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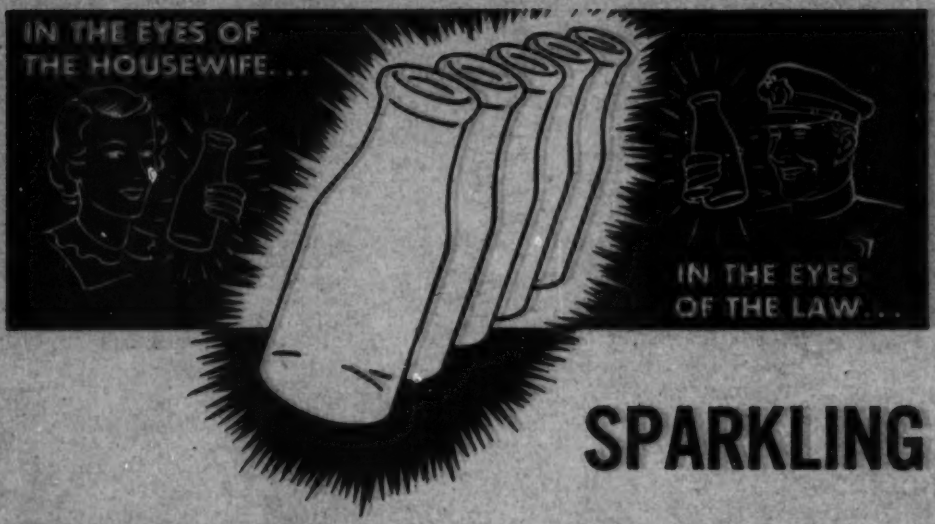

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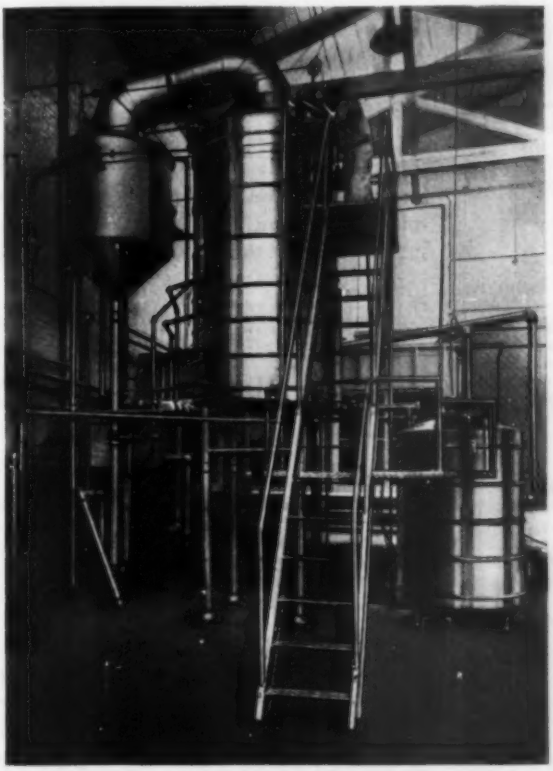

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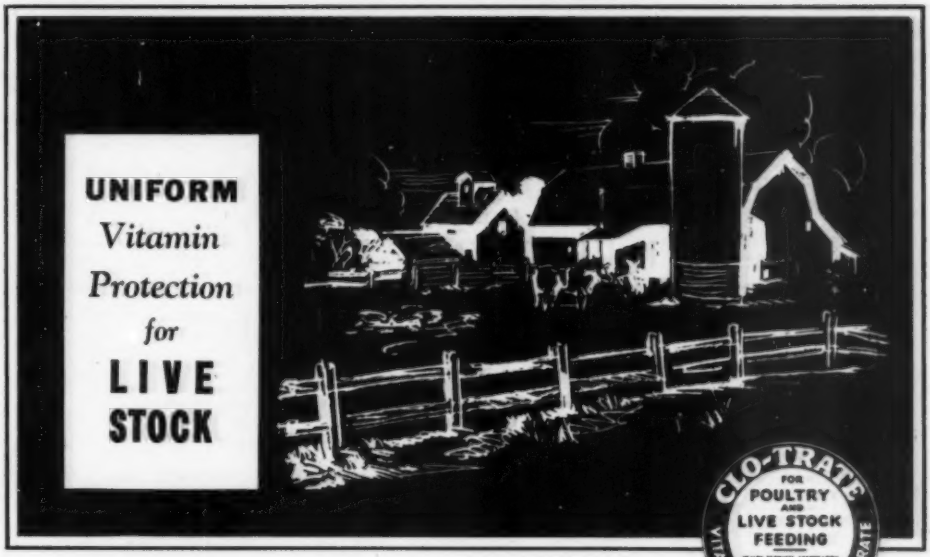

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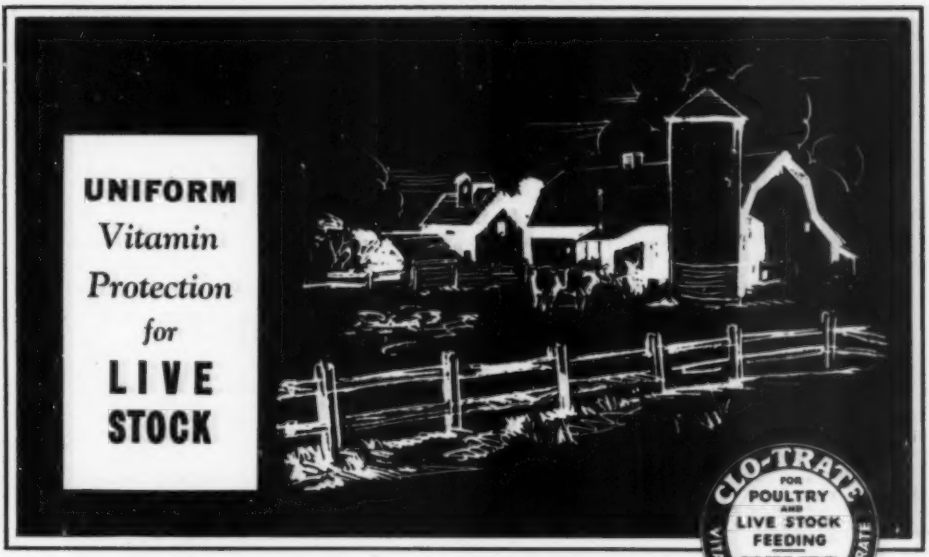

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JOURNAL OF DAIRY SCIENCE

VOLUME XX MARCH, 1937 NUMBER 3

GASTRIC DIGESTION OF SOYBEAN FLOUR*

LAVAN SHOPTAW, D. L. ESPE AND C. Y. CANNON

Dairy Husbandry Subsection, Iowa Agricultural Experiment Station

Most work with milk substitutes for calves has taken the form of feeding trials. Though soybeans have a high nutritive value they have not proved entirely satisfactory for calf feeding when used as a gruel to replace milk (6). In order to better understand the physiological basis of digestion, calves were prepared with gastric fistulas and Pavlov pouches. The method of studying digestion by means of gastric fistulas has already been described (3). Pavlov pouches have not been generally used with ruminants although Belgowski (1) in 1912 reported the successful use of the technique with calves while seven years earlier, Grosser (4) reported its use in goats.

Any milk substitute to be successful in rearing calves must have certain physical as well as chemical properties in common with milk. Soybean flour as placed on the market for infant feeding is more like milk solids than the product used in this experiment in that much of the fiber has been removed while considerable of the fat has been retained. The analyses of soybean flour prepared for livestock purposes, and dry skim milk, are given below (table 1).

TABLE I

Percentage composition of soybean flour and dried skim milk

	WATER	ASH	PROTEIN	CARBOHYDRATES		
				Fiber	N.F.E.	Fat
Soybean flour	7.0	3.0	45.0	7.0	32.0	6.0
Dried skim milk	6.2	8.0	34.8	.....	50.0	0.9

When soybean flour is added to water, the mixture must be constantly agitated in order to prevent a considerable portion from settling out. Rennet or acid will not coagulate it. Sufficient acid or alkali will bring a greater percentage of the flour into solution but as soon as the pH is again adjusted to a point where the product is edible the soybean proteins become insoluble

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in water. This means that instead of a firm curd being formed in the stomach the particles of soybean flour will not adhere together until the acidity of the stomach has increased considerable. In the meantime a large part of the flour has been washed into the abomasum by the water ingested and by the peristaltic movements of the stomach.

The success of the Chinese in the use of soybean milk in infant feeding (8) (9) raised the question of its adaptability for calf feeding. As a result we became interested in determining the influence of soybean flour on the gastric mechanism of calves.

EXPERIMENTAL

Both calves with Pavlov pouches and calves with gastric fistulas were used in these determinations (Table II), which were conducted in three series as follows:

TABLE II

Data on calves used in trials

CALF NO.	BORN	BREED	SEX	DATE WHEN USED IN TRIAL			
				Series I	Series II	Series III	
				12hour experiment (42 trials)	Continuous experiment (49 trials)	16 hour experiment (56 trials)	Acidity curves (44 trials)
				1934	1934	1935	1935
47U	2/14/34	Guernsey	Male	4/4–6/6			
47Y	2/26/34	Holstein	Male	4/4–7/5	7/15–7/28		
47A1	3/6/34	Holstein	Male	4/8–6/6			
47A2	3/7/34	Br. Swiss	Male	6/8–7/2	7/15–7/28		
47A11	6/14/34	Holstein	Female		7/19–7/28		
47A12	6/14/34	Holstein	Female		7/15–7/28		
47A13	12/22/34	Holstein	Female				9/19–11/17
47A14	12/22/34	Holstein	Male				9/19–10/12
47A30	9/19/35	Holstein	Male			10/12–11/13	
47A31	9/19/35	Guernsey	Male			10/15–11/10	
47A32	9/19/35	Guernsey	Male			10/19–11/23	
47A34	9/23/35	Br. Swiss	Male			10/12–11/20	
1306	1/15/35	Ayrshire	Male				9/19–11/17
1344	7/4/35	Holstein	Male			9/15–11/23	

Series 1. A series of twelve-hour trials were run using a test meal of soybean gruel, then a test meal of whole milk. One liter each of the foods to be tested was fed and the effect determined by measuring the rate of secretion, by half-hour intervals, of gastric juice into the Pavlov pouch. A modification of the Dragstedt cannula (2), Fig. 1, was used for collecting the gastric juice.

Series 2. Trials were run for 14 days in which whole milk and soybean gruel were compared in the same manner as in series 1 except that the animals were fed from 3 to 4 pounds per meal (depending on the age of calf)

every 8 hours and the gastric juice collected continuously. The calves were fed soybean gruel for seven days following which they were changed to a similar amount of whole milk and data collected for another seven days.

Series 3. The third series of trials was divided into two parts. (Part 1.) The test meal of one liter of skimmed cows' milk or one-half liter of "fortified" soybean gruel (described below) was fed to calves with Pavlov pouches with the volume of gastric secretion being determined at half-hour

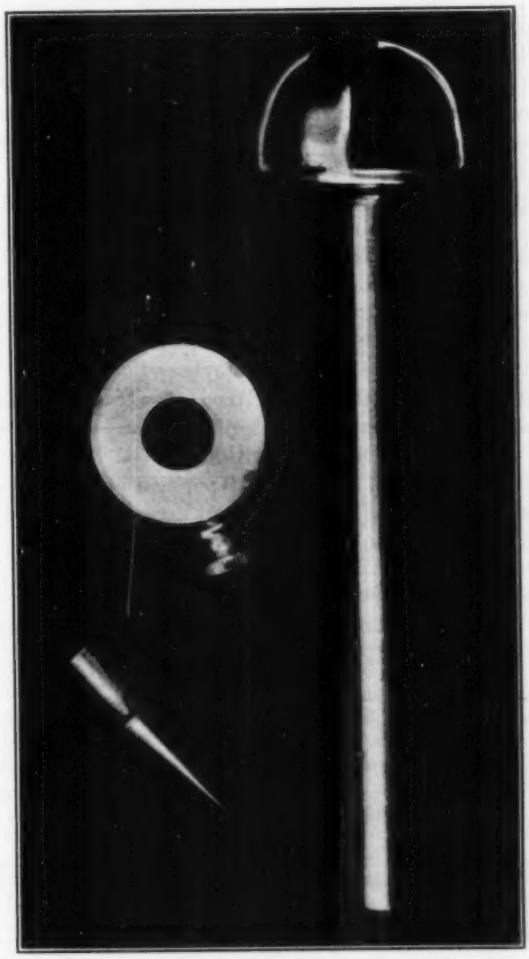

FIG. 1. GASTRIC CANNULA USED IN COLLECTING GASTRIC JUICE FROM PAVLOV POUCH OF CALVES.

intervals. The calves were fed on oatmeal for 12 hours and then fasted 12 hours prior to the feeding of the test meal so that all milk curds would be digested. (Part 2.) Similar meals were fed calves with rumen fistulas. The milk was passed directly to the abomasum by a rubber tube extending through the fistula and the reticulo-omasal and omasal-abomasal orifices. A stomach tube was then inserted in a similar manner so that the weighted end rested on the floor of the abomasum. The upper end was threaded through the plug closing the rumen and connected to a 10 cc. Leur syringe so that samples of gastric juice could be removed at hourly intervals for analysis. The gastric contents were filtered and one cc. of the filtrate titrated with N/100 NaOH. Töpfers reagent and phenolphthalein were used as indicators to determine free and total acidity.

The soybean gruel used in series 1 and 2 was made by stirring soybean flour into warm water at the rate of 1 part flour to 9 parts warm water. The flour was made from hulled beans which were ground, bolted and part of the oil extracted. The analyses are given in table 1. The "fortified" soybean gruel, used in the third series consisted of one-third skim milk solids (as skim milk) and two-thirds soybean flour, with water to make a mixture containing 20 per cent dry matter. Eight cc. of a 40 per cent solution of calcium chloride were added to each liter of this milk since milk will not coagulate normally after the addition of soybean flour.

The whole milk used in the 12-hour trials was from one cow in the College herd and had a fat content of 3.1 per cent and a curd tension of 95 grams. The whole milk used in the continuous trial was from another cow in the College herd having a fat test of 3.0 per cent and a curd tension of 82 grams. Skim milk from the former cow was used as a check in the 16-hour trials, as well as a milieu for the soybean flour.

RESULTS

Series 1. Forty-two trials were run in which whole milk was compared with soybean gruel (Table III).

TABLE III

Number of 12-hour trials with calves fed test meals of whole cow's milk and soybean gruel

CALF NO.	COW'S MILK	NUMBER OF TRIALS	SOYBEAN GRUEL	NUMBER OF TRIALS
47U	(mouth fed)	9	(mouth fed)	3
47A1	(mouth fed)	8	(mouth fed)	3
47Y	(mouth fed)	9	(mouth fed)	5
47A2	(fistula fed)	2	(fistula fed)	3
Total		28		14

Figure 2 shows the average results of these trials for each calf. There was a tendency for the gastric juice to be trapped within the pouch even

with the special crown provided for the cannula. Even when exerting a slight amount of traction on the cannula it would sometimes be necessary to force a little air into the pouch to allow the escape of the gastric juice. In spite of these precautions more or less fluctuation persisted. The authors feel that this secretion was not due to psychic stimulation but that the more complete emptying of the pouch probably resulted from the calf's movements. One of the predominating characteristics of these data which should

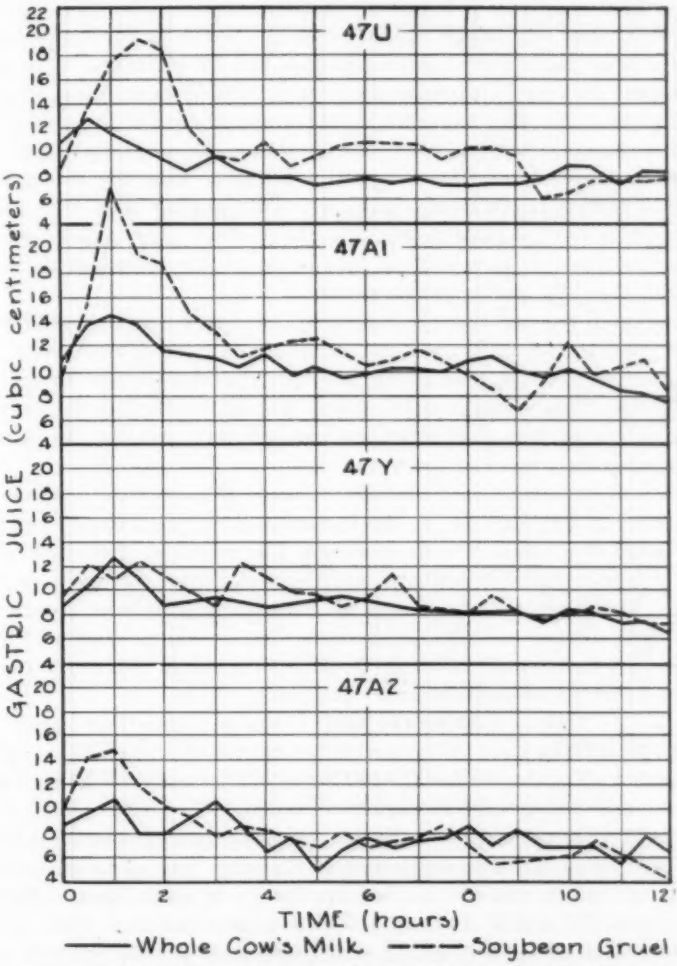

FIG. 2. EFFECT OF ONE LITER OF MILK AND SOYBEAN GRUEL WHEN FED SEPARATELY ON GASTRIC SECRETION OF CALVES.

be noted was the comparatively brief rises in rate of gastric secretion after the ingestion of each test meal. The rate of gastric secretion then fell to its comparatively constant level of secretion which persisted even after it was proved, by exploration through a gastric fistula, that the stomach was empty.

In each instance it will be noted that the calves secreted slightly more total gastric juice during the 12-hour observation periods when fed soybean gruel than when fed whole milk. In that soybean gruel does not form a hard coagulum it leaves the stomach more rapidly than the curd from milk. For this reason the gastric juice for the 12 hours may not reflect the same part of the digestive process in both instances. It is therefore rather difficult to interpret the results. The greater initial secretion with soybean gruel may be caused by the escape of some of the more soluble constituents of the soybean flour with the water. These products may have a greater stimulating action on gastric secretion than the serum which escapes following coagulation of the milk. On the other hand, it is possible that some of the insoluble material in the soybean gruel escapes into the duodenum where it is rapidly broken down by the intestinal fluids and absorbed, thus stimulating gastric secretion.

In spite of the fact that the soybean gruel causes a greater secretion of gastric juice the calves do not grow as rapidly on it as on whole milk. The feces are foul as if the food is only partially digested and the calves scour very easily. This would tend to confirm the suggestion that the too rapid escape of the soybean flour from the stomach may overload the intestine with incompletely digested products.

It should be remembered that the digestion of cow's milk proceeds at a comparatively slow rate due to the formation of a curd immediately upon the passage of the milk into the stomach. The retention of the milk in the stomach is not wholly dependent upon this coagulation, however, for Mortenson (5) found that a test meal of autoclaved milk, which would not curdle with rennet, remained in a calf's stomach for at least two hours. Perhaps even extremely soft-curd milk is retained in the calf's stomach sufficient time for some digestion to take place.

Series 2. Curves showing the results obtained when four calves were full-fed three times a day on soybean gruel and whole cow's milk, are shown in Figure 3. For this series calves 47Y and 47A2 (same two calves used in series 1) were fed by tube through their fistulas. Two other calves, 47A11 and 47A12, were prepared with Pavlov pouches only and consequently were pail fed. These calves were handled in the same way as in the previous experiment except that the calves were fed every eight hours. The two older calves 47Y and 47A2, were fed four pounds per feed while the two younger calves, 47A11 and 47A12, were given three pounds per feed. The feeding hours were 5 : 00 a. m., 1 : 00 p. m., and 9 : 00 p. m. It will be noted from these results that there was little difference in the amount of gastric

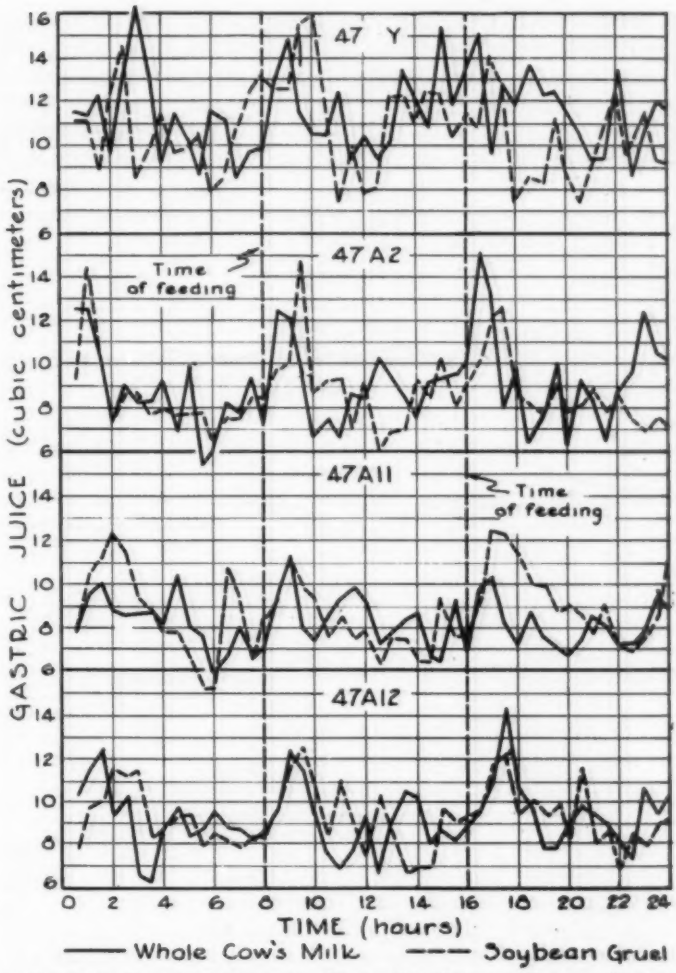

FIG. 3. EFFECT ON GASTRIC SECRETION OF CALVES FED MILK AND SOYBEAN GRUEL (SEPARATELY) EVERY EIGHT HOURS DURING SEVEN-DAY PERIODS.

juice secreted as a result of the two different feeds. Apparently from these data one can conclude that the longer period with milk caused the conflicting results with series 1.

Series 3, Part one. The results of feeding fortified soybean gruel (soybean flour mixed with skim milk and sufficient water to bring to 20 per cent solids, plus the needed $CaCl_2$ to cause the skim milk to coagulate with rennin *in vitro*) and skim milk are shown in figure 4. In these trials one-half liter of the soybean milk was used instead of the customary liter because of its

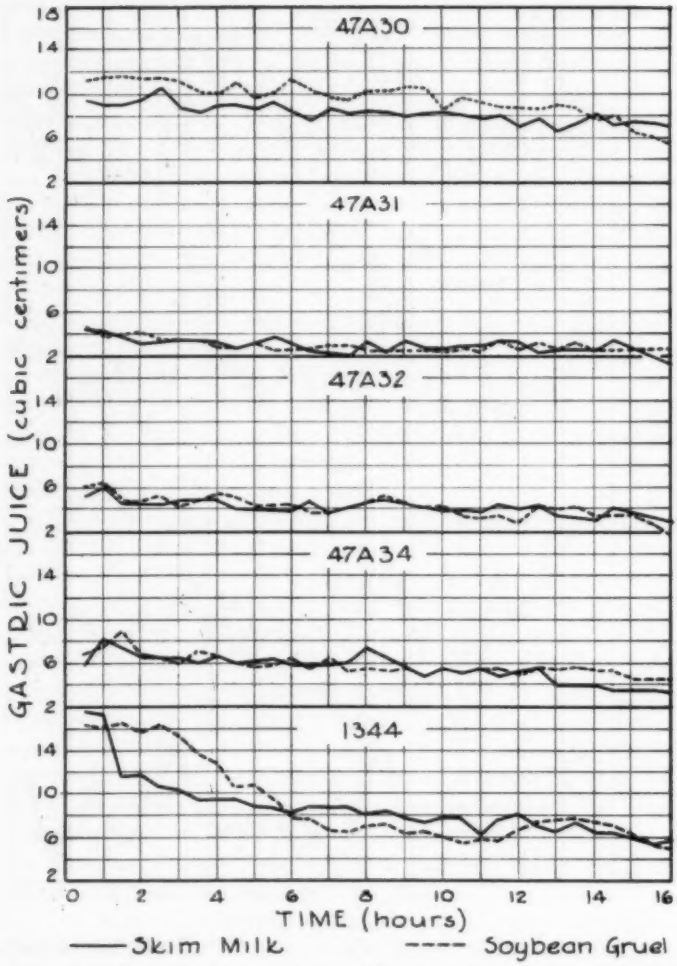

FIG. 4. EFFECT OF SKIM MILK AND "FORTIFIED" SOYBEAN GRUEL WHEN FED SEPARATELY ON GASTRIC SECRETION OF CALVES.

higher solids content. The solids content of the two meals were thus approximately equal but the water ingested with skim milk was approximately double that in the soybean gruel. Five rather young calves were used in these trials (Table II). The amount of gastric juice secreted was again quite comparable on the two types of feed.

Series 3, Part two. The average amount of free and total acid are shown in figure 5. No significant difference between the two types of feed are to be noted. The maximum total acidity occurs between the fourth and fifth hour. The free acid is very limited at any time, rarely any being found until the second hour. The original pH and the acid binding properties of the two feeds are doubtless of importance. The pH of the various milks used in the different series are given in Table IV.

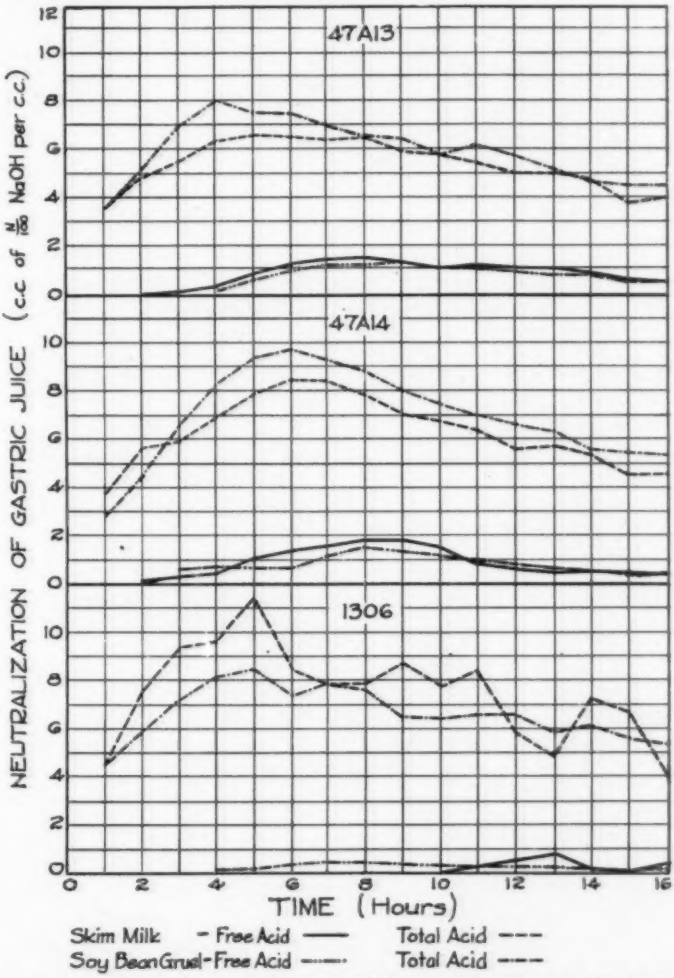

FIG. 5. EFFECT OF SKIM MILK AND "FORTIFIED" SOYBEAN GRUEL WHEN FED SEPARATELY ON THE FREE AND TOTAL ACID OF THE GASTRIC JUICE.

TABLE IV

Hydrogen ion potential of soybean gruels and skim milk

MILKS	pH
Soybean flour in water	6.42
Fortified soybean gruel	6.10
Skim milk	6.70

DISCUSSION

This experiment was begun in the hope of devising a simple milk substitute for calf feeding. Realizing that the physical properties of the food exert a marked influence on its utilization by the calf it was decided to study the digestive processes after feeding soybean gruel rather than depending upon growth data.

When individual trials are run, such as are presented in series 1, it is necessary to empty the rumen and keep the calf on a liquid diet for three days. Twenty-four hours before the trial is started the calf is given a liquid gruel which will not coagulate and will disturb digestion a minimum amount, such as oat meal gruel. One liter has been used as the test meal in order that all results may be as near comparable as possible. However, as the calf grows, the meal becomes comparatively smaller. For this reason the milk and soybean trials were alternated and the results averaged. The twenty-four hour preparatory period plus the twelve to sixteen hour test period makes it necessary to full feed the calf on milk for at least three days before running a second trial. For this reason the trials cover a longer period than was desired. During this time not only the relative and actual size of the different compartments have changed but perhaps the physiological processes have been altered, such as the amount of rennin secreted. Environmental factors, especially temperature, and the physical well being of the calf including appetite are important factors in modifying the rate of gastric secretion. The absence of the degradation products of the paunch as well as the saliva ingested may be of importance. However, these were comparable for the two types of feed used. The results with one calf can only be compared in a general way with the results with another calf in that the size of the Pavlov pouch, the region of the stomach included and the injury to extrinsic nerves will influence the total amount of juice secreted. Acidity curves, using the filtrate from the gastric contents, would aid in interpreting the secretory processes. However, it is impractical to attempt to place a stomach tube in the abomasum by way of the mouth due to difficulty of holding it *in situ*, salivation, and the anatomical arrangement of the esophageal groove. Then, too, unless the rumen was emptied manually before the trial was begun there would be a constant shift of the products from one stomach to another.

The first trials were carried out with whole milk in that only a part of the oil had been removed from the soybean flour. The amount of fat present in either the milk or the soybean gruel probably did not materially modify the length of the digestive period (3). The exact reason for the marked increase in the rate of gastric secretion one hour after feeding soybean gruel is not known. It would appear, however, that a portion of the gruel probably escaped into the duodenum. If soluble products were originally present in the soybean flour which had a secretagogic effect the rate of secretion should have risen more rapidly than it did. This would indicate that the gruel underwent a certain amount of digestion before secretagogic products were available for absorption. Apparently the fluids escaping from the coagulated milk act somewhat more quickly but with less gastric stimulating power. Though these trials also indicate a somewhat higher total gastric secretion on soybean gruel, the lack of confirmatory results in the next two series would indicate that the digestion of the milk was not complete at the end of twelve hours.

The results of individual trials show considerable variation in the amount of gastric juice secreted due probably to the trapping of the gastric juice within the pouch. There is no evidence to indicate that the actual gastric secretion varied in this manner from period to period. The fact that more uniform amounts were secured from some calves than from others would tend to support this conclusion.

During the latter part of the first series and through the entire period of the second series the temperature, even within the barns, was almost intolerable. This extreme heat exhausted the calves so much that blocks of ice were placed in the pens and a fan used to circulate the air. In spite of this precaution there was much to be desired in the way of optimum conditions for the maximum response from feeding. The increase in the average hourly rate of gastric secretion by calves 47Y and 47A2 in series 2 over that in series 1 can probably be accounted for by the larger food intake rather than by the increasing age of the animals.

The solids content of the gruel was increased in series 3 and the milk added as a diluent so that all of the soybean flour might be retained in the abomasum until it could be exposed to the action of the gastric juice. The lack of a high initial secretion on the soybean gruel in the last series may be due to the slower emptying of the stomach. Though Tobler and Bogen (7) found that increasing the amount of milk fed to dogs from 100 to 200 cc. increased the length of the digestive period from 145 to 240 minutes, the effect of the smaller volume in the case of the gruel (one-half liter) would be less serious since the solids content of the two meals remained approximately the same.

The amount of free and total acidity obtained during the second part of series 3, while interesting, throws little light on the problem being investigated. As previously mentioned (3) acidity curves are not a satisfactory criteria for determining the length of the digestive period in calves. The

difference in the amount of free and total acid when milk and soybean gruel was fed is insignificant. The fact that the free acidity did not increase on the "fortified" soybean gruel would tend to indicate that a considerable part of the test meal remained in the stomach for several hours.

The amount of $CaCl_2$ included in the "fortified" soybean gruel should have produced no injurious effect upon the gastric mucosa. However, the chloride ions did increase the acidity of the mixture as well as aid in the coagulation of the milk. Whether the calf would respond by an increase in rate of growth on the "fortified" soybean gruel over the soybean flour water mixture was not determined.

SUMMARY

A soybean gruel made by mixing one part of soybean flour with nine parts of water was compared with whole and skim milk for calf feeding. A "fortified" soybean gruel in which skim milk solids made up one third of the total solids of the gruel was also tried. The results were analyzed in terms of (1) cubic centimeters of gastric juice collected by half hour periods from Pavlov pouches and (2) free and total acidity of the gastric contents. The amount of gastric juice secreted was approximately the same in both the milk and the soybean gruel trials. The data tend to confirm the belief that the soybean flour-water mixture leaves the stomach more rapidly than the milk curd. The data do not furnish the answer to the question of why calves do not thrive on a soybean gruel but they do indicate that it is not due to a diminished gastric secretion.

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A SIMPLIFIED PROCEDURE FOR CALCULATING WEIGHTS OF MILK TO THEIR ENERGY EQUIVALENT IN MILK OF DIFFERENT FAT CONTENT IN ACCORDANCE WITH THE GAINES[1] FORMULA

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The formula introduced by Gaines (1) for the calculation of milk yields to their energy equivalent in terms of 4 per cent milk has come into widespread use. Overman and Gaines (2) have presented additional evidence further establishing the accuracy of the formula. The manner in which the formula is commonly stated,

$$**F.C.M. = 0.4\ M + 15\ F,$$

while seemingly very simple, requires at least four distinct operations and recordings to complete the computation, when the weight of milk and its fat percentage are the known terms.

While using this formula it occurred to the writer that there must be a simpler method of obtaining these results. The method arrived at was as follows: The value of 100 pounds each of milk testing, 2, 3, 4, 5, 6, and 7 per cent fat was calculated to its energy equivalent in 4.0 per cent milk by the Gaines formula. The value for 4 per cent milk was of course 100, since that is the base of the system. The values for 2, 3, 5, 6, and 7 per cent milk, were respectively, 70, 85, 115, 130 and 145. By moving the decimal point two places to the left the factor was obtained by which weights of milk of these respective fat contents may be multiplied to indicate in each case the energy equivalent amount of 4.0 per cent milk, expressed in the same weight unit. If these values are plotted as a curve they will be found to lie in a straight line. It follows that a given increase as 1.0 per cent in fat content corresponds to the same increase in energy content of the milk at all places on the curve. When 4.0 per cent milk is the base each change of 1.0 per cent in fat contnt from that level corresponds to a 15 per cent change in energy value of the milk; or, each tenth of one per cent change in fat content corresponds to a 1.5 per cent change in energy value, the corresponding conversion

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* The writer is deeply indebted to Dr. W. L. Gaines for valuable suggestions which he has contributed.

** Gaines gives the following explanation of these symbols and expressions:

F.C.M. = Milk energy in terms of normal whole cow's milk of 4.0 per cent fat content.

M = Weight of milk; F = Weight of fat, all expressed in the same unit of weight. One pound of F.C.M. equals 340 calories, or, E (in calories) equals 340 F.C.M. lb.

factor for 0.1 per cent change in fat content being 0.015. The simplified method of converting a given weight of milk of other fat content to its energy equivalent weight of 4.0 per cent milk is then as follows: The deviation of the fat content from 4.0 per cent is noted in terms of tenths of one per cent. This deviation is multiplied by 0.015. In case the deviation is positive or the milk in question is above 4.0 in fat content the product is added to 1.0 to obtain the desired conversion factor. If the deviation from 4.0 per cent fat content is negative the product of its multiplication by 0.015 is subtracted from 1.0 to obtain the desired factor.

These processes are so simple that they may usually be carried out mentally but in case one objects to too much mental arithmetic, the factors may conveniently be arranged in tabular form as presented in Table 1.

TABLE 1

Factors for converting weights of milk of other fat content to their energy equivalent weight of 4.0 per cent milk

*f	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
2	.700	.715	.730	.745	.760	.775	.790	.805	.820	.835
3	.850	.865	.880	.895	.910	.925	.940	.955	.970	.985
4	1.000	1.015	1.030	1.045	0.060	1.075	1.090	1.105	1.120	1.135
5	1.150	1.165	1.180	1.195	1.210	1.225	1.240	1.255	1.270	1.285
6	1.300	1.315	1.330	1.345	1.360	1.375	1.390	1.405	1.420	1.435
7	1.450	1.465	1.480	1.495	1.510	1.525	1.540	1.555	1.570	1.585

* f = fat per cent.

Each of the numerical values in this table is a solution of the expression $(.4 + 0.15\ f)$ for the corresponding value of f; for use in the formula,

$$F.C.M. = M\ (.4 + 0.15\ f)^1$$

which is an alternate, but little used statement of the Gaines formula.

Table 1 is carried only to 0.1 per cent intervals of variation in the percentage fat content. If so desired the values may easily be interpolated to 0.01 per cent fat since the intervals are proportional throughout the range. It seems doubtful to the writer, however, whether the accuracy of the data on which the formula is based would justify so minute an interpretation of the results.

We have since found that Brody and Ragsdale (3) have published a similar though less complete table for use in connection with other data in determining the comparative efficiency of large and small cows.

Multiplication of the weight of milk of any natural fat content by the appropriate factor will give the energy equivalent weight of 4.0 per cent milk in terms of the same unit of weight. It should be pointed out that this relationship will not hold in the case of milk whose fat content has been artificially altered in any way. The results obtained by this method are identical with those obtained by using the customary statement of the Gaines

formula except as either may be slightly affected by the dropping of incompleted decimals.

It may sometimes be desirable to calculate the equivalent amount of milk to some other base than 4.0 per cent. The Gaines formula expresses the energy value of milk of any fat content. It should therefore be possible to compute similar factors or increments for converting milk of any given fat content to its energy equivalent amount of milk of any other basic fat content. Gaines (1) has suggested the foregoing use of his formula but did not give a detailed procedure.

One suitable procedure for this calculation follows: It may be recalled or noted from Table 1 that there is a constant difference of 0.15 in the factors for each per cent of difference in fat content. This difference of 0.15 in the factor represents the energy associated with a 1.0 per cent increase in fat content. It remains constant for all values of f.

If the value of 0.15 (A) is divided by the factor from Table 1 representing the energy value of milk of a definite fat content (B), the quotient will represent the energy value accompanying a 1.0 per cent fat increase A, in terms of the energy value of the milk selected, (B). Thus, 0.15 divided by 0.85 the factor for 3.0 per cent milk equals 0.1765 indicating that in the case of 3.0 per cent milk each per cent of increase in fat content increases the energy value of the milk by 0.1765 or 17.65 per cent.

Table 2 has been prepared showing corresponding values for 1.0 per cent increase of fat content in terms of milk ranging from 2.0 to 7.0 per cent fat content by 0.5 per cent intervals.

TABLE 2

FAT CONTENT OF MILK	VALUE OF 1.0 PER CENT INCREASE IN FAT CONTENT AS A PERCENTAGE OF THE ENERGY VALUE OF THIS MILK
2.0	21.43 per cent
2.5	19.34
3.0	17.65
3.5	16.22
4.0	15.00
4.5	13.95
5.0	13.04
5.5	12.24
6.0	11.54
6.5	10.91
7.0	10.35

If desired a table similar to Table 1 could be constructed based on any one of these levels of fat content and the corresponding percentage of increased energy value brought about by 1 per cent increase in fat content, as shown in Table 2.

The numerical value of the factor representing a given increase in fat content is not the same in different parts of this table; therefore the values for milk intermediate in fat content between those shown will need to be obtained by direct calculation rather than by interpolation of the values given in Table 2. Each value given in Table 2 gives the change in energy value of the milk for 1.0 per cent change in fat content. Values for 0.1 per cent change may be found by the relocation of the decimal point.

Some question has arisen as to the desirability or usefulness of figures such as presented in Table 2. In this connection it should be recalled that a large proportion of the milk sold commercially is paid for with reference to a 3.5 per cent rather than a 4.0 per cent basic fat content and that either 3 per cent or 3.5 per cent are the lower legal limits of fat content of milk in many states. Producers, dealers and consumers alike should be interested in such simple and accurate information regarding the relation of additional fat content to the food or energy value of the milk they sell or purchase.

The Gaines formula was introduced and has been used chiefly for reducing the production of different cows to common terms to facilitate comparison between them. For this particular purpose conversion to 4.0 per cent milk is convenient and as suitable as any other common measure. However, as suggested above this is by no means the only field of usefulness for the formula, once its significance is better understood. The data presented in Table 2 may be considered as a step in this direction. The energy values of milk of different fat content as calculated by this method agree well with actual calorimetric determinations as reported by Overman and Sanmann (4) and Savini and Garzia (5).

A simplified procedure has been described for the use of the Gaines formula in comparing milk yields. Other uses for the formula are also suggested and a table presented which will facilitate its use for these purposes

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OXIDIZED FLAVOR IN MILK

IV. STUDIES OF THE RELATION OF THE FEED OF THE COW TO OXIDIZED FLAVOR*

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Apparently the earliest work dealing with the relation of the feed given cows to oxidized flavor development in the milk was done by Kende (5) in 1932. He reported that oleaginous (oxidized) flavor seems to occur only during the winter, and also that green feed as well as the fresh hay produced from it contain considerable amounts of reducing substances which tend to prevent oxidized flavor development or lessen its intensity, whereas certain so-called industrial feeds, especially sliced beets, lack these reducing substances and seem to favor oxidized flavor development in the milk from cows to which they are fed. Mayer (6) has found that the tallowing (oxidized flavor) action of beet forage can be prevented by the addition to the ration of corresponding amounts of fresh alp hay, which supports Kende's belief that fresh forage contains reducing substances which pass to the milk and prevent oxidized flavor development.

It was shown by Kende, and substantiated by Guthrie and Brueckner (4), that some milks develop oxidized flavor spontaneously (that is, without the addition of copper or iron). Kende attributes this effect to the absence of reducing substances in the feed and consequently in the milk.

The foregoing review indicates that the feed given the cow plays an important rôle in controlling the susceptibility of the milk to oxidized flavor development. In order to learn more concerning the effect of the feed of the cow on oxidized flavor development in milk the experiments herein reported were planned and conducted. These experiments include: a weekly study of the susceptibility of the mixed milk from certain cows in the herd, which were fed and cared for by the methods used in the management of the regular herd, throughout one year; a frequent study of the susceptibility of the milks of all individual cows in the Experiment Station herd, with the exception of those cows on certain special feeding experiments, throughout more than a year; a study of the susceptibility of the milks of nine individual cows, which were alternated between dry feeding and dry feeding

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plus pasturing regimes; and, studies of the effects of feeding vitamin C-rich substances, and of feeding vitamin C itself, on the susceptibility of the milks of three individual cows.

EXPERIMENTAL

Susceptibility of Mixed Milks Throughout a Year

In carrying on this study it would have been desirable to have taken samples of mixed milk from the entire herd, but a number of the cows were on special feeding experiments, which warranted the exclusion of their milks. Also, at the time the study was begun, the condition of the cooler and strainers at the farm was such that exposed copper surfaces made it impossible to avoid copper contamination. For this reason the mixed milk used in this experiment was from the first cows milked each time, excepting those on special feeding experiments, and the milk was neither strained nor cooled at the barn. When ten gallons of milk had been obtained the collection of milk for sampling was stopped and the milk was brought to the laboratory for sampling within the hour. The milk of Jersey and Guernsey cows was used for the sample and an average of five to eight cows was usually required to obtain sufficient sample.

Seven quart samples were saved in quart milk bottles and immersed in ice water. One of these samples served as a control and received no treatment while to the six remaining samples 1.3, 2.6, and 3.9, parts per million of copper and 31, 62, and 93 parts per million of iron were added, respectively, from solutions of either copper sulphate or ferric chloride. The samples thus prepared were stored at approximately 40° F. for three days, after which they were tasted to determine the intensity of the oxidized flavor developed. This procedure was repeated once each week throughout one year. No samples were pasteurized in conducting this experiment.

The significant results are recorded in Table 1. Since 2.6 and 3.9 parts per million of copper did not increase the intensity of the oxidized flavor developed these results were omitted from the table.

The outstanding facts shown by these results appear to be that (1) the mixed milk never developed oxidized flavor when no copper or iron was added to it; (2) that much more iron than copper is required to produce oxidized flavor and, (3) that the changing of the cows from dry feeding to a dry feeding plus pasturing regime caused the milk to become non-susceptible to oxidized flavor development. Weekly studies show that the change occurred very soon after the cows were given pasture. The results show also that the milk produced in December, 1934, was much more susceptible than the milk produced in December, 1935. It would seem that the variation in the susceptibility of the milk toward oxidized flavor development throughout the year may be explained fairly satisfactorily on the basis of variations in the feed of the cows. Apparently pasture grasses

TABLE 1

Effect of dry feeding versus pasture supplemented by dry feeding on the susceptibility of non-pasteurized milk to oxidized flavor development

PERIOD	FLAVOR OF RAW MILK SAMPLES AFTER 3 DAYS' STORAGE AT APPROXIMATELY 40° F.				
	Added Cu in p.p.m.		Added Fe in p.p.m.		
	None	1.3	31	62	93
Cows on dry feed					
12/6/34–4/11/35	—	4	—	2	3
Cows pastured—one-half day beginning 4/15/35—full day 4/24/35					
4/25–11/13/35	—	—	—	—	—
Cows on dry feed after 11/17/35					
11/21–12/11/35	—	—*	—	—	—

Note: Samples were taken each week except during long periods of no change when they were taken at two-week intervals.

* The use of 2.6 p.p.m. of added copper gave a very slight oxidized flavor.

Meaning of symbols: —, no oxidized flavor; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; 6, very pronounced oxidized flavor.

contain one or more substances which pass to the milk and act in such a manner as to retard or prevent oxidized flavor development even though copper or iron is added.

Susceptibility of the Milks of Individual Cows

During much of the same period in which the study of the susceptibility of mixed milk just described was being conducted, experiments studying the susceptibility of the milk of each individual cow in the herd were being carried on also. These studies were made at varying intervals in order to have information as to the susceptibility of the individual animals for use in connection with other phases of the oxidized flavor work, and they also serve to show to some extent the effect of the food on susceptibility.

In each case one person, charged with the responsibility of taking these individual samples, remained at the station dairy farm during the period when the evening milking was being done and supervised the sampling. The milk was drawn into aluminum buckets, and four pint-bottles were filled with the milk of each cow. As soon as all the samples were taken they were brought to the laboratory. To each of two of the pint samples of each cow's milk 1.3 parts per million of copper were added in the form of copper sulphate solution whereas nothing was added to the two other samples. Of the samples from each cow, one containing the added copper and another containing no added copper were stored at approximately 40° F., whereas the duplicates of these samples were pasteurized at as near 143° F. as possible by immersion of the bottle in hot water. The pasteurized samples, after cooling were stored along with the non-pasteurized samples. After a three-day storage period the samples were tasted. Six

difference in the amount of free and total acid when milk and soybean gruel was fed is insignificant. The fact that the free acidity did not increase on the "fortified" soybean gruel would tend to indicate that a considerable part of the test meal remained in the stomach for several hours.

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2	.700	.715	.730	.745	.760	.775	.790	.805	.820	.835
3	.850	.865	.880	.895	.910	.925	.940	.955	.970	.985
4	1.000	1.015	1.030	1.045	0.060	1.075	1.090	1.105	1.120	1.135
5	1.150	1.165	1.180	1.195	1.210	1.225	1.240	1.255	1.270	1.285
6	1.300	1.315	1.330	1.345	1.360	1.375	1.390	1.405	1.420	1.435
7	1.450	1.465	1.480	1.495	1.510	1.525	1.540	1.555	1.570	1.585

* f = fat per cent.

Each of the numerical values in this table is a solution of the expression $(.4 + 0.15\ f)$ for the corresponding value of f; for use in the formula,

$$F.C.M. = M\ (.4 + 0.15\ f)$$

which is an alternate, but little used statement of the Gaines formula.

Table 1 is carried only to 0.1 per cent intervals of variation in the percentage fat content. If so desired the values may easily be interpolated to 0.01 per cent fat since the intervals are proportional throughout the range. It seems doubtful to the writer, however, whether the accuracy of the data on which the formula is based would justify so minute an interpretation of the results.

We have since found that Brody and Ragsdale (3) have published a similar though less complete table for use in connection with other data in determining the comparative efficiency of large and small cows.

Multiplication of the weight of milk of any natural fat content by the appropriate factor will give the energy equivalent weight of 4.0 per cent milk in terms of the same unit of weight. It should be pointed out that this relationship will not hold in the case of milk whose fat content has been artificially altered in any way. The results obtained by this method are identical with those obtained by using the customary statement of the Gaines

formula except as either may be slightly affected by the dropping of incompleted decimals.

It may sometimes be desirable to calculate the equivalent amount of milk to some other base than 4.0 per cent. The Gaines formula expresses the energy value of milk of any fat content. It should therefore be possible to compute similar factors or increments for converting milk of any given fat content to its energy equivalent amount of milk of any other basic fat content. Gaines (1) has suggested the foregoing use of his formula but did not give a detailed procedure.

One suitable procedure for this calculation follows: It may be recalled or noted from Table 1 that there is a constant difference of 0.15 in the factors for each per cent of difference in fat content. This difference of 0.15 in the factor represents the energy associated with a 1.0 per cent increase in fat content. It remains constant for all values of f.

If the value of 0.15 (A) is divided by the factor from Table 1 representing the energy value of milk of a definite fat content (B), the quotient will represent the energy value accompanying a 1.0 per cent fat increase A, in terms of the energy value of the milk selected, (B). Thus, 0.15 divided by 0.85 the factor for 3.0 per cent milk equals 0.1765 indicating that in the case of 3.0 per cent milk each per cent of increase in fat content increases the energy value of the milk by 0.1765 or 17.65 per cent.

Table 2 has been prepared showing corresponding values for 1.0 per cent increase of fat content in terms of milk ranging from 2.0 to 7.0 per cent fat content by 0.5 per cent intervals.

TABLE 2

FAT CONTENT OF MILK	VALUE OF 1.0 PER CENT INCREASE IN FAT CONTENT AS A PERCENTAGE OF THE ENERGY VALUE OF THIS MILK
2.0	21.43 per cent
2.5	19.34
3.0	17.65
3.5	16.22
4.0	15.00
4.5	13.95
5.0	13.04
5.5	12.24
6.0	11.54
6.5	10.91
7.0	10.35

If desired a table similar to Table 1 could be constructed based on any one of these levels of fat content and the corresponding percentage of increased energy value brought about by 1 per cent increase in fat content, as shown in Table 2.

The numerical value of the factor representing a given increase in fat content is not the same in different parts of this table; therefore the values for milk intermediate in fat content between those shown will need to be obtained by direct calculation rather than by interpolation of the values given in Table 2. Each value given in Table 2 gives the change in energy value of the milk for 1.0 per cent change in fat content. Values for 0.1 per cent change may be found by the relocation of the decimal point.

Some question has arisen as to the desirability or usefulness of figures such as presented in Table 2. In this connection it should be recalled that a large proportion of the milk sold commercially is paid for with reference to a 3.5 per cent rather than a 4.0 per cent basic fat content and that either 3 per cent or 3.5 per cent are the lower legal limits of fat content of milk in many states. Producers, dealers and consumers alike should be interested in such simple and accurate information regarding the relation of additional fat content to the food or energy value of the milk they sell or purchase.

The Gaines formula was introduced and has been used chiefly for reducing the production of different cows to common terms to facilitate comparison between them. For this particular purpose conversion to 4.0 per cent milk is convenient and as suitable as any other common measure. However, as suggested above this is by no means the only field of usefulness for the formula, once its significance is better understood. The data presented in Table 2 may be considered as a step in this direction. The energy values of milk of different fat content as calculated by this method agree well with actual calorimetric determinations as reported by Overman and Sanmann (4) and Savini and Garzia (5).

A simplified procedure has been described for the use of the Gaines formula in comparing milk yields. Other uses for the formula are also suggested and a table presented which will facilitate its use for these purposes

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OXIDIZED FLAVOR IN MILK

IV. STUDIES OF THE RELATION OF THE FEED OF THE COW TO OXIDIZED FLAVOR*

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Apparently the earliest work dealing with the relation of the feed given cows to oxidized flavor development in the milk was done by Kende (5) in 1932. He reported that oleaginous (oxidized) flavor seems to occur only during the winter, and also that green feed as well as the fresh hay produced from it contain considerable amounts of reducing substances which tend to prevent oxidized flavor development or lessen its intensity, whereas certain so-called industrial feeds, especially sliced beets, lack these reducing substances and seem to favor oxidized flavor development in the milk from cows to which they are fed. Mayer (6) has found that the tallowing (oxidized flavor) action of beet forage can be prevented by the addition to the ration of corresponding amounts of fresh alp hay, which supports Kende's belief that fresh forage contains reducing substances which pass to the milk and prevent oxidized flavor development.

It was shown by Kende, and substantiated by Guthrie and Brueckner (4), that some milks develop oxidized flavor spontaneously (that is, without the addition of copper or iron). Kende attributes this effect to the absence of reducing substances in the feed and consequently in the milk.

The foregoing review indicates that the feed given the cow plays an important rôle in controlling the susceptibility of the milk to oxidized flavor development. In order to learn more concerning the effect of the feed of the cow on oxidized flavor development in milk the experiments herein reported were planned and conducted. These experiments include: a weekly study of the susceptibility of the mixed milk from certain cows in the herd, which were fed and cared for by the methods used in the management of the regular herd, throughout one year; a frequent study of the susceptibility of the milks of all individual cows in the Experiment Station herd, with the exception of those cows on certain special feeding experiments, throughout more than a year; a study of the susceptibility of the milks of nine individual cows, which were alternated between dry feeding and dry feeding

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plus pasturing regimes; and, studies of the effects of feeding vitamin C-rich substances, and of feeding vitamin C itself, on the susceptibility of the milks of three individual cows.

EXPERIMENTAL

Susceptibility of Mixed Milks Throughout a Year

In carrying on this study it would have been desirable to have taken samples of mixed milk from the entire herd, but a number of the cows were on special feeding experiments, which warranted the exclusion of their milks. Also, at the time the study was begun, the condition of the cooler and strainers at the farm was such that exposed copper surfaces made it impossible to avoid copper contamination. For this reason the mixed milk used in this experiment was from the first cows milked each time, excepting those on special feeding experiments, and the milk was neither strained nor cooled at the barn. When ten gallons of milk had been obtained the collection of milk for sampling was stopped and the milk was brought to the laboratory for sampling within the hour. The milk of Jersey and Guernsey cows was used for the sample and an average of five to eight cows was usually required to obtain sufficient sample.

Seven quart samples were saved in quart milk bottles and immersed in ice water. One of these samples served as a control and received no treatment while to the six remaining samples 1.3, 2.6, and 3.9, parts per million of copper and 31, 62, and 93 parts per million of iron were added, respectively, from solutions of either copper sulphate or ferric chloride. The samples thus prepared were stored at approximately 40° F. for three days, after which they were tasted to determine the intensity of the oxidized flavor developed. This procedure was repeated once each week throughout one year. No samples were pasteurized in conducting this experiment.

The significant results are recorded in Table 1. Since 2.6 and 3.9 parts per million of copper did not increase the intensity of the oxidized flavor developed these results were omitted from the table.

The outstanding facts shown by these results appear to be that (1) the mixed milk never developed oxidized flavor when no copper or iron was added to it; (2) that much more iron than copper is required to produce oxidized flavor and, (3) that the changing of the cows from dry feeding to a dry feeding plus pasturing regime caused the milk to become non-susceptible to oxidized flavor development. Weekly studies show that the change occurred very soon after the cows were given pasture. The results show also that the milk produced in December, 1934, was much more susceptible than the milk produced in December, 1935. It would seem that the variation in the susceptibility of the milk toward oxidized flavor development throughout the year may be explained fairly satisfactorily on the basis of variations in the feed of the cows. Apparently pasture grasses

TABLE 1

Effect of dry feeding versus pasture supplemented by dry feeding on the susceptibility of non-pasteurized milk to oxidized flavor development

PERIOD	FLAVOR OF RAW MILK SAMPLES AFTER 3 DAYS' STORAGE AT APPROXIMATELY 40° F.				
	Added Cu in p.p.m.		Added Fe in p.p.m.		
	None	1.3	31	62	93
Cows on dry feed					
12/6/34–4/11/35	—	4	—	2	3
Cows pastured—one-half day beginning 4/15/35—full day 4/24/35					
4/25–11/13/35	—	—	—	—	—
Cows on dry feed after 11/17/35					
11/21–12/11/35	—	—*	—	—	—

Note: Samples were taken each week except during long periods of no change when they were taken at two-week intervals.

* The use of 2.6 p.p.m. of added copper gave a very slight oxidized flavor.

Meaning of symbols: —, no oxidized flavor; 1, very slight oxidized flavor; 2, slight oxidized flavor; 3, moderate oxidized flavor; 4, fairly pronounced oxidized flavor; 5, pronounced oxidized flavor; 6, very pronounced oxidized flavor.

contain one or more substances which pass to the milk and act in such a manner as to retard or prevent oxidized flavor development even though copper or iron is added.

Susceptibility of the Milks of Individual Cows

During much of the same period in which the study of the susceptibility of mixed milk just described was being conducted, experiments studying the susceptibility of the milk of each individual cow in the herd were being carried on also. These studies were made at varying intervals in order to have information as to the susceptibility of the individual animals for use in connection with other phases of the oxidized flavor work, and they also serve to show to some extent the effect of the food on susceptibility.

In each case one person, charged with the responsibility of taking these individual samples, remained at the station dairy farm during the period when the evening milking was being done and supervised the sampling. The milk was drawn into aluminum buckets, and four pint-bottles were filled with the milk of each cow. As soon as all the samples were taken they were brought to the laboratory. To each of two of the pint samples of each cow's milk 1.3 parts per million of copper were added in the form of copper sulphate solution whereas nothing was added to the two other samples. Of the samples from each cow, one containing the added copper and another containing no added copper were stored at approximately 40° F., whereas the duplicates of these samples were pasteurized at as near 143° F. as possible by immersion of the bottle in hot water. The pasteurized samples, after cooling were stored along with the non-pasteurized samples. After a three-day storage period the samples were tasted. Six

studies were made at the beginning of this experiment from which samples containing added copper were omitted, and in one of these studies only pasteurized milk was examined, because at that time it was intended to determine only the extent of spontaneous oxidized flavor development.

TABLE 2

Seasonal variation in the susceptibility of milks of individual cows to oxidized flavor development

DATE	*PERCENTAGE OF MILKS EXAMINED THAT SHOWED OXIDIZED FLAVOR IN			
	Raw milk		Pasteurized milk	
	No copper	1.3 p.p.m. copper	No copper	1.3 p.p.m. copper
	Cows on dry feed			
2/19/35			31	
3/15/35	6		29	
4/13/35	0		7	
	Cows pastured 6 hours per day beginning 4/15/35			
4/22/35	0		10	
	Cows pastured day and night beginning 4/25/35			
4/29/35	0		3	
5/6/35	0		3	
5/13/35	0	7	0	0
5/27/35	0	11	0	4
6/11/35	0	18	4	25
6/17/35	0	25	0	29
7/2/35	0	13	0	3
7/15/35	0	7	0	10
	Pasture supplemented by silage beginning 7/24/35			
7/29/35	0	6	0	9
8/12/35	0	6	0	3
8/26/35	0	3	0	19
9/16/35	0	3	0	6
9/30/35	0	3	0	9
	Full winter ration supplemented by pasture beginning 10/15/35			
10/15/35	0	6	0	26
	Cows stabled at night beginning 10/25/35			
10/28/35	0	0	0	26
11/11/35	0	0	0	17
	Cows received no pasture supplement beginning 11/18/35			
11/29/35	0	6	0	27
12/12/35	0	9	6	12
12/23/35	0	5	0	41
1/7/36	missed	3	0	missed
1/13/36	6	36	9	58
1/27/36	0	13	6	45
2/10/36	0	13	0	53
2/17/36	0	16	0	22
2/24/36	0	29	0	50
3/2/36	3	35	3	62
3/9/36	0	38	0	24
3/16/36	0	18	0	10
3/23/36	0	31	0	31
3/30/36	5	49	5	47
4/6/36	0	36	14	19
4/12/36	0	23	2	5
4/20/36	0	36	0	21
	Cows on pasture beginning 4/22/36			
5/6/36	0	3	0	0

* Smallest number of cows studied at any time, 27; largest number studied, 43.

The results of this work, recorded in Table 2, indicate, as did the experiments with mixed milk, that the feed of the cows has a very pronounced effect on the susceptibility of the milk to oxidized flavor development. The feeding regime also is closely related to the tendency for spontaneous development of oxidized flavor. Thus, during February and March, 1935, and until pasturing was begun, a considerable percentage of the milks to which no copper had been added developed oxidized flavor. During the pasturing season practically no spontaneous development of oxidized flavor occurred and the susceptibility of the milks, as tested by the addition of copper, was reduced greatly. It would seem that the feeds used during February and March, 1935, favored the spontaneous development of oxidized flavor to a considerably greater extent than those used during the same months of 1936. It is probable that the hay fed during these months of 1936 contained more reducing substances than that fed during the same months of 1935.

The Effects of Reversals Between Dry- and Pasture-Feeding Regimes

The results of the foregoing experiments indicated the desirability of conducting a more carefully controlled experiment studying the effects of pasture on the susceptibility of milk to oxidixed flavor development. Accordingly eight cows were selected and placed on a reversal feeding experiment just before the beginning of the pasture season of 1935. Another cow, No. 384, that freshened after the start of the pasture season, was placed on the experiment at that time. The feeds used for the dry feeding regime consisted of yellow cornmeal, wheat bran, cottonseed meal, bone meal, and common salt in the grain mixture with first and second cutting alfalfa hay as the roughage. When the cows were on pasture the supplementary dry feeds consisted of the same grain mixture.

It was planned at first to keep the cows on the experiment in two groups and to reverse all the animals of one group from dry feeding to pasture feeding regimes or *vice versa* at one time. However, it became evident soon that the cows differed greatly in their tendencies to produce susceptible or non-susceptible milks under identical conditions of feeding and for this reason reversals were made individually whenever complete susceptibility changes occurred. In so far as possible, reversals from the dry-feeding to the pasture-feeding regimes were made whenever the milk became susceptible to oxidized flavor devlopment and the opposite reversals were made whenever the milk became non-susceptible. The milk of one cow, No. 365, did not lose its susceptibility entirely during a long pasture-feeding regime. However, the intensity of the flavor decreased during the pasturing regime and further pasturing was prevented because she became dry.

Determination of the susceptibility of these milks to oxidized flavor development was made by tasting the raw and pasteurized milk of each cow, both with and without added copper after a three-day period of storage at approximately 40° F. The method of preparing the samples was the same as that described for the preceding experiment in which the susceptibility of the milks of individual cows was determined. During the first two weeks of the experiment the milk of each cow was tested for susceptibility one day each week, but thereafter it was studied on three consecutive days each week.

Unfortunately the experiments reported in a previous paper of this series (2) had not been done when this work was started, and consequently the authors were not aware of the importance of the addition of copper after pasteurization rather than before when studying the susceptibility of milk to oxidized flavor development. In this work all pasteurized milks contaminated with added copper received the copper before pasteurization. For this reason the results with the raw milk probably are of greater significance than the results with the pasteurized milk in this particular study.

The results of this work, recorded in Table 3, indicate, as did the foregoing experiments studying susceptibility, that pasture has a pronounced effect on the susceptibility of the milk to oxidized flavor development.

Considerable variation was found in the susceptibility of the milks of the individual cows on this experiment. The milks from six cows, Nos. 318, 367, 368, 371, 374 and 384, were rendered non-susceptible readily by the pasture-feeding regime, whereas the milks from the three remaining cows, Nos. 364, 365, 379, were affected less readily by pasture. Even in the cases of the latter animals the intensity of the oxidized flavor developed after the addition of copper was decreased considerably by the pasturing regime.

In the case of cow No. 379 spontaneous development of oxidized flavor (without the addition of copper) occurred during the dry feeding regime, but ceased almost immediately after she was turned on pasture. Her milk did not lose its susceptibility entirely although she was continued on the pasturing regime for fourteen weeks. At the end of that time she was removed from the herd because of low production. During the latter part of the pasturing period the grass became short and dry because of drouth. Furthermore, this animal was known to be a poor grazer.

The milk from cow No. 365 did not lose its susceptibility entirely at any time during the experiment. However, the intensity of the oxidized flavor diminished considerably during the pasturing regime which followed a period of dry feeding. Because of advancing gestation this cow had to be turned dry, and was discontinued from the experiment.

On the other hand, the milk of cow No. 371 showed the most ready response of any of the cows on this experiment to reversals between dry and

TABLE 3

Studies of the effect of dry feeding versus pasturing supplemented by dry feeding on the susceptibility of milk to oxidized flavor development

WEEKS		1	2	3	4	5	6	7	8	9	10	11	12
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	?	?	?2–	223	–?1	222	223	--3	442	24–	---	---
318	Pasteurized milk	–	–	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	?	4	421	422	422	4--	342	2–1	433	1--	?12	--1
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	?	444	444	424	444	444	331	444	434	11–	421
364	Pasteurized milk	–	–	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	4	4	?34	444	?44	214	224	433	232	21–	--1	211
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	4	444	444	444	444	443	121	311	231	331	222
365	Pasteurized milk	–	–	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	4	4	421	222	–44	422	244	242	32?	1–1	232	122
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	4	4--	3–3	--?	---	---	---	---	2--	?--	–1–
367	Pasteurized milk	–	–	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	4	4	?–2	4–2	131	?1?	2–1	12–	331	1--	?–?	11–
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	4	4?2	2–2	–2–	---	---	--2	--1	32–	2--	??–
368	Pasteurized milk	–	–	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	4	4	224	444	144	412	1--	422	?22	322	211	121
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	4	?--	?--	---	---	---	–22	212	314	421	---
371	Pasteurized milk	–	3	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	4	4	??–	?24	11–	---	---	221	31?	142	32–	1--
Cow	Raw milk	–	–	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	–	---	--3	---	---	---	–??	413	434	?1–	---
374	Pasteurized milk	–	–	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	?	?	---	--?	---	---	---	–11	312	432	12–	---
Cow	Raw milk	–	4	---	--?	---	–3–	?--	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	4	6	564	445	545	444	544	555	444	444	544	444
379	Pasteurized milk	–	4	444	424	–22	?23	2--	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	4	–	242	4–4	445	1??	243	333	422	132	333	322
Cow	Raw milk										---	---	---
No.	Raw milk + 1.3 p.p.m. Cu										1--	---	---
384	Pasteurized milk										---	---	---
	Past. + 1.3 p.p.m. Cu										---	---	---

TABLE 3.—*Continued*

	WEEKS	13	14	15	16	17	18	19	20	21	22	23	24
Cow	Raw milk	---	---	---	---	---	---	---					
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	---	---	---					
318	Pasteurized milk	---	---	---	---	---	---	---					
	Past. + 1.3 p.p.m. Cu	---	---	---	---	-11	--1	11-					
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	441	122	1?1	-11	-1-	---	-?-	333	132	1?3	-2-	---
364	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	211	11-	?2-	-11	1--	---	4--	11-	1-?	1-2	-1-	---
Cow	Raw milk	---	---	---	---	---	---	---					
No.	Raw milk + 1.3 p.p.m. Cu	112	121	211	?12	221	--1	2?1					
365	Pasteurized milk	---	---	---	---	---	---	---					
	Past. + 1.3 p.p.m. Cu	--2	?1?2	211	---	-1-	--1	?--					
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	--2	221	--?	432	---	3--	---	---	---
367	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	---	---	---	1?1	-1-	--2	32-	---	2--	---	---	---
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	---	---	1?3	434	3--	---	--	---
368	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	--1	-11	111	--1	---	---	41-	232	131	---	---	---
Cow	Raw milk	---	---	---	---	---	---	---					
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	---	--1	444					
371	Pasteurized milk	---	---	---	---	---	---	---					
	Past. + 1.3 p.p.m. Cu	1--	-1-	---	---	---	--2	41?					
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	---	---	-?-	112	?11	---	---	---	---	---	---	---
374	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	---	---	---	1?2	-11	---	---	---	---	---	---	---
Cow	Raw milk	---	---	---	---	---	---	---	---	---			
No.	Raw milk + 1.3 p.p.m. Cu	444	444	444	223	332	?-1	---	-22	-33			
379	Pasteurized milk	---	---	---	--	---	---	---	---	---			
	Past. + 1.3 p.p.m. Cu	213	111	211	3-3	2--	---	---	---	-32			
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	--2	111	111	--3	-1-	--3	-1-	311	---	---	---	---
384	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	---	---	---	--2	221	--2	221	1?2	1--	---	---	---

TABLE 3.—*Continued*

	WEEKS	25	26	27	28	29	30	31	32	33	34	35	36
Cow	Raw milk												
No.	Raw milk + 1.3 p.p.m. Cu												
318	Pasteurized milk												
	Past. + 1.3 p.p.m. Cu												
Cow	Raw milk	---	---										
No.	Raw milk + 1.3 p.p.m. Cu	**-24**	**444**										
364	Pasteurized milk	---	---										
	Past. + 1.3 p.p.m. Cu	**133**	**344**										
Cow	Raw milk												
No.	Raw milk + 1.3 p.p.m. Cu												
365	Pasteurized milk												
	Past. + 1.3 p.p.m. Cu												
Cow	Raw milk	---	---	---	---	---	---	---	---	---			
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	**1--**	---	**--2**	---	---			
367	Pasteurized milk	---	---	---	---	---	---	---	---	---			
	Past. + 1.3 p.p.m. Cu	**--2**	**-32**	**4--**	**211**	**-34**	**342**	**232**	**432**	**343**			
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	**1--**	**--2**	**-23**	**--?**	**1?2**	**343**	**442**	**422**
368	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	**1-3**	**-22**	**3--**	**332**	**-33**	**323**	**434**	**433**	**434**	**442**	**444**	**233**
Cow	Raw milk												
No.	Raw milk + 1.3 p.p.m. Cu												
371	Pasteurized milk												
	Past. + 1.3 p.p.m. Cu												
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	---	---	---	---	---	---	---	---
374	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	**12-**	**-33**	**---**	**21?**	**---**	**--2**	**-??**	**-34**	**-43**	**?41**	**241**	**22-**
Cow	Raw milk												
No.	Raw milk + 1.3 p.p.m. Cu												
379	Pasteurized milk												
	Past. + 1.3 p.p.m. Cu												
Cow	Raw milk	---	---	---	---	---	---	---	---	---	---	---	---
No.	Raw milk + 1.3 p.p.m. Cu	---	---	---	---	---	---	---	---	**-?-**	**-?2**	**31-**	**--2**
384	Pasteurized milk	---	---	---	---	---	---	---	---	---	---	---	---
	Past. + 1.3 p.p.m. Cu	**-23**	**---**	**2--**	**---**	**---**	**?2-**	**---**	**-3-**	**--2**	**-1-**	**2-1**	**?-3**

Meaning of symbols: Boldface type, Cows on dry feed; lightface type, Cows on pasture.

For meaning of other symbols see Table 1, footnote. Study was begun the week of April 4 and finished the week of December 9, 1935.

pasture feeding regimes so that it was possible to make four reversals of feeding in her case.

Collectively considered the data show that subject to considerable individual variation the feeding of fresh pasture grasses to cows results in a reduction or elimination of susceptibility of their milks to oxidized flavor development.

Effects of Tomato Juice, Lemon Juice, and Ascorbic Acid

The experiments described in the foregoing paragraphs indicate quite conclusively that pasture grass contains a substance, or substances, capable of passing from the digestive system of the cow to the milk and lessening the intensity of, or preventing entirely, the subsequent occurrence of oxidized flavor. In all probability, as Kende (5) has pointed out, such a substance has strong reducing properties. Probably also it is readily oxidized itself. The work of Chilson (3) shows that the addition of ascorbic acid (vitamin C) to milk, prevents the development of oxidized flavor. This was true also for additions of two other reducing substances elone and hydroquinone. It might be expected therefore that the effect of green feeds on oxidized flavor development is to be explained on the basis of their relatively high vitamin C content. Accordingly an experiment studying the effects of feeding vitamin C-rich substances and of feeding vitamin C in purified form was planned and conducted.

Three cows known to be producing milk susceptible to oxidized flavor development were selected. These cows were continued on the dry feeds they were receiving when selected. This feed was supplemented by 1 quart of a popular brand of canned tomato juice for each cow daily, administered by drenching. The allowance of tomato juice was doubled after 6 days. Samples of the milk from each cow were handled so as to avoid contamination with copper in the manner described in connection with the other experiments herein reported. The results, reported in the forepart of Table 4, show that the feeding of tomato juice caused a notable reduction in the susceptibility of the milks of these cows to oxidized flavor development and that this susceptibility returned within a short time after the feeding of tomato juice was discontinued.

When the milks of the three cows used had become readily susceptible to oxidized flavor development again, one of the cows was given a daily supplement of 0.5 gram of ascorbic acid (Merck's "Cebione") dissolved in slightly less than a quart of distilled water that was slightly acidulated with citric acid. (This allowance was believed to be approximatley equivalent to the amount of ascorbic acid contained in two quarts of tomato juice, as shown by the work of Bessey and King (1).) Each of the two other cows was given a daily supplement of one quart of lemon juice, freshly extracted.

The results of this experiment, recorded in the latter part of Table 4, show that the ascorbic acid had a pronounced effect in reducing the susceptibility of the milk to oxidized flavor development. Unfortunately not enough

TABLE 4

The effects of supplementary feeding of tomato juice, lemon juice, and pure vitamin C on the susceptibility of milks to oxidized flavor development

cow	No. 377				No. 378				No. 385			
Treatment	Raw		Pasteurized		Raw		Pasteurized		Raw		Pasteurized	
Copper added (p.p.m.)	None	2.6	None	2.6	None	2.6	None	2.6	None	2.6	None	2.6
Date												
					Dry feeding regime							
4/14/36	–	3	–	2	–	3	–	4	–	3	–	4
4/15/36	–	4	–	4	–	4	–	4	–	2 to 3	–	3
4/16/36	–	3	–	4	–	3	–	4	–	3 " 4	–	3 to 4
4/17/36	–	3	–	3	–	4	–	4	–	2 " 3	–	3
					Dry feed supplemented by 1 quart of tomato juice daily							
4/18/36	–	1 to 2	–	1 to 2	–	2	–	2	–	1	–	1 to 2
4/19/36	–	1	–	?	–	2 to 3	–	2 to 3	–	2 to 3	–	1 " 2
4/20/36	–	?	–	1	–	1 " 2	–	2 " 3	–	1	–	2
4/21/36	–	?	–	1	–	–	–	1	–	1	–	1
4/22/36	–	?	–	?	–	?	–	1	–	1	–	1
4/23/36	–	1	–	?	–	?	–	1	–	1	–	1
					Dry feed supplemented by 2 quarts of tomato juice daily							
4/24/36	–	?	–	1	–	–	–	–	–	–	–	–
4/25/36	–	?	–	–	–	–	–	?	–	1	–	?
4/26/36	–	–	–	–	–	–	–	–	–	?	–	?
4/27/36	–	1	–	?	–	–	–	–	–	–	–	–
4/28/36	–	?	–	?	–	–	–	–	–	–	–	–
4/29/36	–	?	–	?	–	–	–	–	–	–	–	–
4/30/36	–	?	–	?	–	?	–	?	–	–	–	?
					Dry feed without supplement 5/1/36							
5/ 2/36	–	?	–	?	–	–	–	–	–	?	–	1
5/ 3/36	–	1	–	?	–	–	–	–	–	1	–	?
5/ 4/36	–	–	–	–	–	1	–	1	–	1	–	?
5/ 5/36	–	1	–	1	–	–	–	1	–	1	–	1
5/ 6/36	–	2	–	1	–	?	–	2	–	?	–	?
5/ 7/36	–	2	–	2	–	1	–	2	–	2	–	2
5/ 8/36	–	3	–	3	–	1 to 2	–	2 to 3	–	1	–	3
5/ 9/36+	–	1	–	1 to 2	–	2	–	2 " 3	–	1	–	1
5/10/36	–	2 to 3	–	1	–	2	–	3	–	?	–	1
5/11/36	–	2	–	2	–	1 to 2	–	2	–	1	–	2
5/12/36	–	1	–	1	–	1	–	1 to 2	–	1	–	1
5/13/36	–	2	–	1 to 2	lost	lost	–	2	–	1	–	2
5/14/36	–	2	–	2	–*	–*	–	1 to 2	–	2	–	1
5/15/36	–	2	–	2	–*	–*	–	2	–	2	–	2
5/16/36	–	3	–	2	–*	–*	–	1 to 2	–	2 to 3	–	3 to 4
5/17/36	–	3	–	3	–*	–*	–	2	–	4	–	4
5/18/36	–	4	–	4	–*	–*	–	2	–	3	–	3
5/19/36	–	4	–	4	–**	–**	–	2	–	3	–	3
5/20/36	–	4	–	3			–	2	–	4	–	3
5/21/36	–	4	–	4			–	2	–	3	–	3
5/22/36	–	4	–	3 to 4			–	3	–	3	–	3

TABLE 4.—*Continued*

cow	No. 377				No. 378				No. 385			
Treatment	Raw		Pasteurized		Raw		Pasteurized		Raw		Pasteurized	
Copper added (p.p.m.)	None	2.6	None	2.6	None	2.6	None	2.6	None	2.6	None	2.6
	Dry feed supplemented by 0.5 gram Merck's Cebione (Vitamin C) daily						Dry feed supplemented by 1 quart lemon juice daily				Dry feed supplemented by 1 quart lemon juice daily	
5/23/36	–	4	–	3			–	3	–	4	–	3
5/24/36	–	4	–	3			–	3	–	3 to 4	–	3
5/25/36	–	1	–	–			–	1 to 2	–	2	–	1
5/26/36	–	2	–	?			–	3	–	2	–	1
5/27/36	–	2	–	1			–	2	–	2	–	1
5/28/36	–	2	–	1			–	1	–	2	–	1
5/29/36	–	?	–	?			–	–	–	1 to 2	–	?
5/30/36	–	1	–	?			–	–	–	–	–	–
	Feeding of Vitamin C discontinued 5/30/36				Feeding of lemon juice discontinued 5/31/36				Feeding of lemon juice discontinued 5/31/36			
5/31/36	–	1 to 2	–	?			–	–	–	–	–	?
6/ 1/36	–	2	–	1			–	–	–	–	–	3
6/ 2/36	–	2 to 3	–	1 to 2			–	?	–	3	–	3
6/ 3/36	–	3	–	2			–	1	–	2 to 3	–	3
6/ 4/36	–	4	–	3			–	2 to 3	–	3	–	3
6/ 5/36	–	4	–	4			–	2	–	3	–	4
6/ 6/36	–	3	–	4			–	3	–	4	–	4
6/ 7/36	–	3	–	4			–	4	–	4	–	4
6/ 8/36	–	3	–	4			–	3	–	5	–	4

Meaning of symbols: +, cows received 2 hours' pasture; *, slight rancid; **, rancid. For meaning of other symbols see Table 1, footnote.

ascorbic acid was on hand to continue the feeding of it until susceptibility was completely eliminated. However, the marked reduction in susceptibility, followed by its rise after the feeding of ascorbic acid was discontinued, is good evidence that vitamin C passes to the milk and tends to make it non-susceptible to oxidized flavor development. A parallel effect of the feeding of lemon juice, also shown in Table 4, is further evidence that vitamin C in the feed of the cow affects her milk, reducing its susceptibility to oxidized flavor development.

SUMMARY AND CONCLUSION

A study of the susceptibility of both individual and mixed milks to oxidized flavor development throughout a period of a year showed the following results:

(1) There is considerable variation among individual cows with respect to the tendency for oxidized flavor to develop in their milks.

(2) Dry feeding increased the tendency for oxidized flavor to develop in milk, and grazing on fresh pasture decreased this tendency.

(3) The feeding of one quart per animal daily of either tomato or lemon juice to cows on dry feed greatly reduced the susceptibility of the milks to oxidized flavor development.

(4) Pure crystalline ascorbic acid fed at the rate of one-half gram daily, likewise greatly decreased the tendency for oxidized flavor to develop.

Since fresh green vegetation, tomato juice, and lemon juice all are known to contain considerable amounts of vitamin C, and since the feeding of small amounts of pure ascorbic acid produced a similar effect, it seems reasonable to conclude that vitamin C in the rations of dairy cows may reduce or entirely eliminate the susceptibility of their milks to oxidized flavor development.

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THE USE OF FORMATE–RICINOLEATE BROTH IN CONTROLLING AND PREVENTING ROPY MILK EPIDEMICS

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Despite the excellent information available for controlling ropy milk, this defect continues to be a problem to the dairy industry. Ropy milk is closely associated with sanitation and proper plant methods and when the latter become lax, ropy milk and other defects are apt to develop.

Investigations of the past have shown that ropy milk bacteria are widely distributed where milk is produced and handled. They have been found in feeds, barn dirt, water holes, raw milk, utensils, milk plants, etc. (1, 2). Realizing the above facts, it is plain to see that most, if not all milk plants receive a certain number of ropy milk bacteria in the raw milk supply and the organisms are often prevalent in the plant itself. The problem then is to recognize the universal distribution of these organisms on the farm and in the plant and to adopt effective methods for their control.

The best authorities on dairy bacteriology are confident and convinced that ropy milk can be controlled in the plant by proper sanitation and efficient pasteurization with no recontamination after pasteurization. Rogers, Sherman, and Hastings (3) state as follows: "Whenever the bottled milk is affected, it is well to assume that contamination has occurred after pasteurization, and take every precaution to eliminate the bacteria throughout the plant." Recontamination after pasteurization is perhaps more common than is realized, as may be seen by the figures quoted by Stark (4): "Results obtained in this laboratory and also much more extensive data (Tiedeman, *et al*, 1935), made available through the kindness of Mr. W. D. Tiedeman, have shown between 11 per cent and 40 per cent of the pasteurized milk which showed no colon organisms at the end of the holding period to contain these organisms when the milk comes from the bottler."

One method commonly employed in controlling ropy milk outbreaks is to set producers' samples at 60–65° F. and test them at intervals for ropiness. There will always be a small percentage of the samples which will become ropy, even when there is no ropy milk in the pasteurized product. Ropy bacteria often predominate in raw milk of high quality and such milk will often rope before it sours. The ropy sample may have developed from very few ropy bacteria but such samples are always possible sources of future trouble. When one is confronted with a serious ropy milk outbreak, and it is necessary to test all possible sources, producers' samples may be set at 60–65° F. and tested at various intervals for rope, to determine the extent of

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contamination. However, to prevent or correct ropy milk epidemics our experience, as well as that of others (3, 5, 6), has indicated that tests made on the product at various stages as it passes through the plant operations will detect the major cause of the trouble. The plant operator will know long before the consumer if the product becomes ropy and can take steps for its correction. As very few, if any, of the process samples would become ropy, they would not be a source of contamination for the plant.

Ropy milk has been shown to be due to a number of different organisms. Hammer (7) ascribes many ropy milk outbreaks in the United States to *Bacterium lactis viscosum* and organisms of the Escherichia-Aerobacter group. Stark and Foter (1) isolated five hundred ropy milk cultures from various sources and divided them into seven distinct groups. Two of the groups which comprised the majority of the cultures isolated, were Gram-negative, gas producing rods, which they believed to be members of the Escherichia-Aerobacter group of organisms. Most of the ropy milk outbreaks in New York State, at least, are caused by organisms of the Escherichia-Aerobacter group.

It is believed that a selective medium such as formate-ricinoleate broth (8) which permits organisms of the Escherichia-Aerobacter group to grow rapidly and produce gas and inhibits the so-called false test organisms, is of great value in controlling and preventing ropy milk outbreaks as well as other defects in milk products. Stark and Curtis (9) testing various culture media for water and milk analysis found that formate-ricinoleate broth was best suited for the detecting of colon organisms in milk.

TABLE I

The value of formate-ricinoleate broth as a detector of ropy milk bacteria in the product during various stages of processing

PLANT PROCESS SAMPLES	GAS IN FORMATE-RICINOLEATE BROTH AFTER 20 HOURS AT 98 °F.	ROPE IN ORIGINAL SAMPLE AFTER 20 HOURS AT 60–65 °F.
Pasteurized heavy cream from can	+	+
Pasteurized heavy cream from bottler	+	+
Bottle of pasteurized heavy cream	+	–
Pasteurized light cream from can	+	–
Pasteurized light cream from bottler	+	–
Bottle of pasteurized light cream	+	+
Milk from vat No. 1, preheated to 144° F.	–	–
Milk from vat No. 1 after being held 30 minutes at 144° F.	–	–
Sample of milk taken from pipe leading to the bottler. (Cream did not go through this pipe, but was dumped directly into the bottler)	–	–
Sample of milk taken from the bottler	+	+
First bottle of milk	+	+

This medium has been used successfully in one plant for eliminating ropy milk, together with correcting faulty plant practices and sanitation. Plant process samples may be taken one morning and in most cases interpreted the next day before plant operations begin. The presence of Escherichia-Aerobacter organisms in pasteurized milk or cream is an indication of recontamination resulting from faulty plant sanitation and methods. After the samples have been examined and the point of recontamination has been located, steps may be taken immediately to correct the fault.

Table I shows the results of process samples taken in one plant during a ropy milk epidemic showing that the cream (which was bottled first), was the source of the ropy organisms in the milk. The pasteurized milk was free of ropy milk bacteria until it came in contact with the bottler, where it was contaminated by the cream remaining in the filler. It will be noted that samples which showed gas in formate-ricinoleate broth developed rope when held 20 hours at 60–65° F.

Table II shows the results of the samples taken the second day when the cream was bottled last.

TABLE II

Other tests showing the value of formate-ricinoleate broth

PLANT PROCESS SAMPLES	GAS IN FORMATE-RICINOLEATE BROTH AFTER 20 HOURS AT 98 °F.	ROPE IN ORIGINAL SAMPLE AFTER 20 HOURS AT 60–65 °F.
Milk from vat No. 1, preheated to 144° F.	–	–
Milk from vat No. 1, after being held 30 minutes at 144° F.	–	–
Sample of milk taken from pipe leading to the bottler	–	–
Sample of milk taken from the bottler	–	–
Pasteurized heavy cream from can	+	+
Pasteurized heavy cream from bottler	+	+
Bottle of pasteurized heavy cream	+	+
Pasteurized light cream from can	+	+
Pasteurized light cream from bottler	+	+
Bottle of pasteurized light cream	+	+

This does not imply that when a sample of pasteurized milk or cream contains Escherichia-Aerobacter organisms as demonstrated by the presence of gas in formate-ricinoleate broth, that it will necessarily develop rope when placed at 60–65° F., but it is a potential ropy and gassy product. However, a pasteurized product free from Escherichia-Aerobacter organisms is safe from the standpoint of rope in most, if not all cases.

Formate-ricinoleate broth may be further used during ropy milk outbreaks to detect unsanitary conditions and faulty plant methods. Samples may be inoculated into formate-ricinoleate broth and in most cases the results

may be read before operations begin the next morning. This test is rather delicate and will detect any defect in sterilization of equipment or recontamination after pasteurization. It was several days in the aforementioned ropy outbreak before pasteurized heavy and light cream could be obtained which was free from Escherichia-Aerobacter organisms. Contamination was traced to the cooler, dipper and the cans.

SUMMARY

Ropy milk bacteria are present practically everywhere milk is handled. They can be controlled in the plant by proper sanitation and plant methods. Checking plant process samples routinely for ropiness and other defects is more effective than checking producers' samples.

Most ropy milk outbreaks in New York State are caused by members of the Escherichia-Aerobacter group of bacteria. The value of formate-ricinoleate broth in detecting ropy milk bacteria and faulty plant sanitation and methods is pointed out. Plant process samples showing gas in formate-ricinoleate broth may or may not develop rope, but samples showing no gas will not develop rope in most, if not all cases when samples are placed at 60–65° F.

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PERSISTENCY OF PRODUCTION IN JERSEY COWS AND ITS PRACTICAL APPLICATION

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Aside from external factors, the production record completed by any cow depends on initial maximum yield plus persistency of production during the lactation. Persistency of production is difficult to define but may be expressed or measured as the rate of decline in milk and fat yield from the maximum production after parturition until milk secretion ceases. For years breeders have recognized that some cows hold up in their milk flow remarkably well for a long time while others tend to dry off sooner than they should. Various methods and means of measuring persistency have been suggested and investigators have attempted to evolve a satisfactory method of expressing persistency of production by a single numerical figure. It is not the attempt of this paper to review the published work that has been done but instead to present some observations on persistency of production as observed in Jersey cows and to attempt to show the practical significance of persistency.

The official Register of Merit, Advanced Registry and Herd Test records as now published in annual volumes by the Breed Associations giving only the total milk and butterfat yields do not furnish as much information as may be desired regarding persistency. However, the month by month records on file in the Breed Association offices do provide inviting material for the study of persistency of milk and butterfat production.

There are just twenty Jersey cows that have completed yearly Class A records of over one thousand pounds of butterfat. These were selected for analysis. The cows with Class AA records were excluded to eliminate any influence due to advanced pregnancy. The twenty records were then divided into twelve thirty day periods discarding the last five days of each lactation. The exact milk and butterfat yields, were calculated for each thirty day period. From these yields the percentage of the total 360 day production produced in each thirty day period was determined. These percentages were then charted. Figure 1, shows a composite graph of the lactation curves for these records as thus determined.

It will be noted that the composite curves show a gain in production for the second thirty day period, then a gradual and almost regular decline for the remainder of the year. This seems to bear out Turner's (1) statement that when all other conditions are uniform, the monthly milk or fat yield during the lactation period, after the maximum is past, is a constant percentage of the preceding month's production. These percentages for milk yield were found to be 95.6, 93.8, 95.4, 96.5, 96.5, 96.4, 98.8, 97.6, 97.2 and

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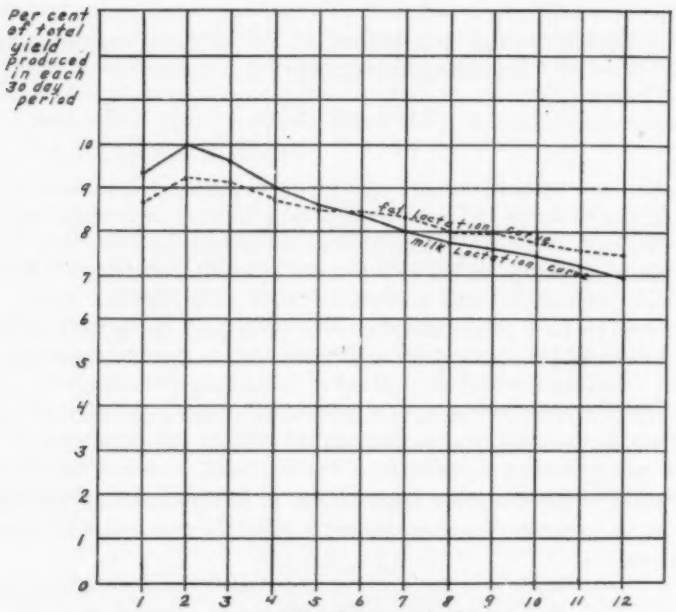

Figure 1. Composite lactation curves for all 1000 lbs. fat, Class A records

96.1. Several of the individual records, however, do show considerable variation in the lactation curve.

For a direct comparison, thirty yearly Class A records which failed to meet the minimum Register of Merit requirements were selected at random. Lactation curves for these low records were similarly determined and are shown in figure 2.

These curves show pronounced variation from the curves in the first figure and the two graphs illustrate extremes in persistency of lactation. The average monthly milk yield of each month was compared with the preceding month's milk production and the percentages were found to be 93.6, 90.4, 92.4, 90.8, 92.6, 93.3, 89.5, 92.0, 89.3 and 83.2. Since these were all Class A records indicating that any pregnancy during the lactation was of less than 155 days in length, it is hardly possible that pregnancy could have caused the greater decline during the last month. Perhaps management and feeding were mainly responsible.

For a third comparison, thirty, 305 day Class A records also failing to meet the Register of Merit requirements were selected at random. The production for each thirty day period was calculated and the last five days discarded. The percentage of the total yield produced in each thirty day

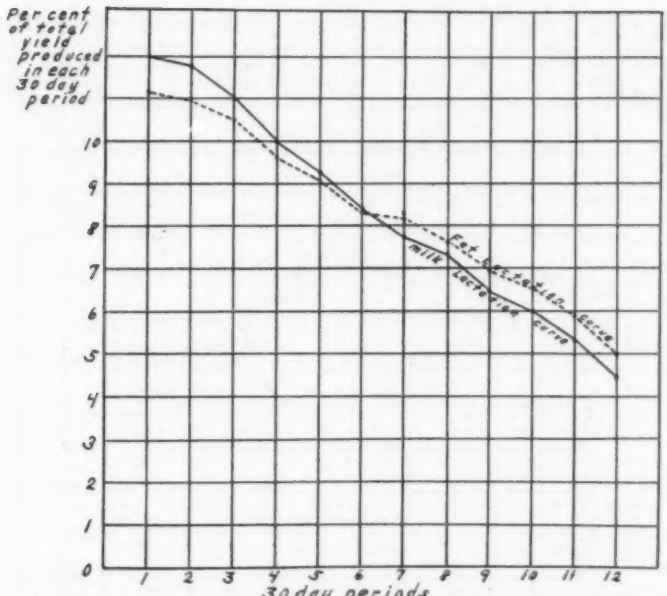

Figure 2: Composite lactation curves for 30, yearly, "failed to qualify", Class A, records

period was then determined and these percentages plotted. The results are given in figure 3.

In these records the average rate of decline in milk and butterfat yield was found to be even more pronounced. Comparing each month's yield with the preceding month's yield, after the second month the percentages were found to be 90.6, 90.1, 90.1, 88.0, 88.8, 90.0, 85.7 and 77.8. Here again the rate of decline was remarkably constant up until the eighth month and then the decline became considerably more pronounced. In all three groups these percentages show slightly more uniformity based on butterfat yields than on milk yields and it would appear that Turner's statement applies even more closely to fat or to total energy yield than to milk yield alone. In both of these low record groups a great variation in persistency was observed. Comparing the 360 and 300 day productions with the maximum month yield, it was found that there existed a considerable range in total yield with cows producing about the same amount during their maximum month.

In the 360 day group, the maximum thirty day yield was 58.86 pounds of fat with a total yield of 336.73 pounds of fat. The cow with the lowest maximum thirty day yield had a thirty day production of 35.48 pounds of fat and a total yield of 352.94 pounds of fat. In the 300 day group, the highest maximum thirty day yield was 54.74 pounds of fat with a total yield

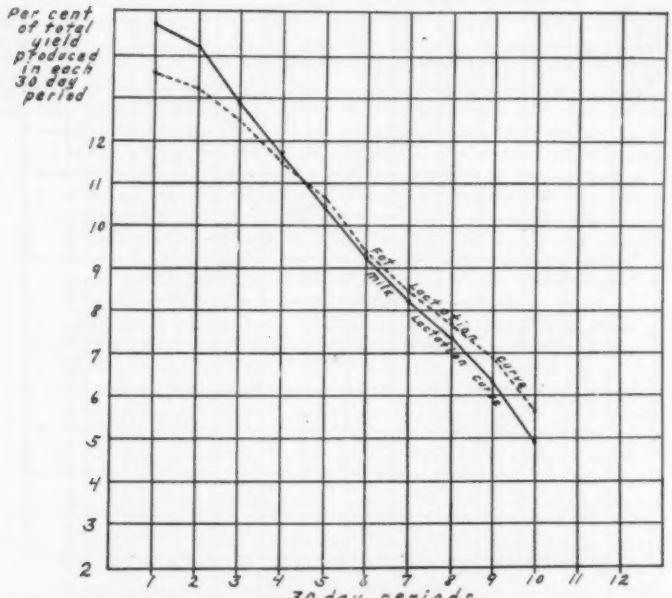

Figure 3. Composite lactation curves for 30 "failed to qualify", 305 day, Class A, records

of 329.78 pounds, while the low maximum thirty day yield was 28.58 pounds with a total production of 224.09 pounds.

It was also observed that with the thousand pound producers sixteen cows produced more milk during their second thirty day period than during the first thirty day period. With the low yearly record cows, only eleven out of thirty produced more milk during the second thirty day period than during the first thirty day period and with the 300 day low record cows, in twenty-two cases, the most milk was produced in the first thirty day period.

The lactation curves for fat and milk were also plotted individually for each record and it was noticed that the rate of decline was less in a few cases with the low record cows than with the thousand pound fat producers, again demonstrating that total yield alone is not an infallible indication or measure of persistency.

Figure 4 shows the fat percentages for each of these three groups. While the high record cows were invariably higher testers, the rate of increase in fat test during the lactations was fairly similar for all three groups. Fat percentage did show a slightly greater increase in the 300 day low record cows than in the other groups and it seems possibly the reason for this was that the production of these cows was extremely low during the ninth and tenth months of their records. In fact, the average milk yield for the tenth

month of this group was 282 pounds of milk, whereas the average tenth month milk yield for the yearly low record group was 409 pounds and the average twelfth month milk yield for this group was 300 pounds.

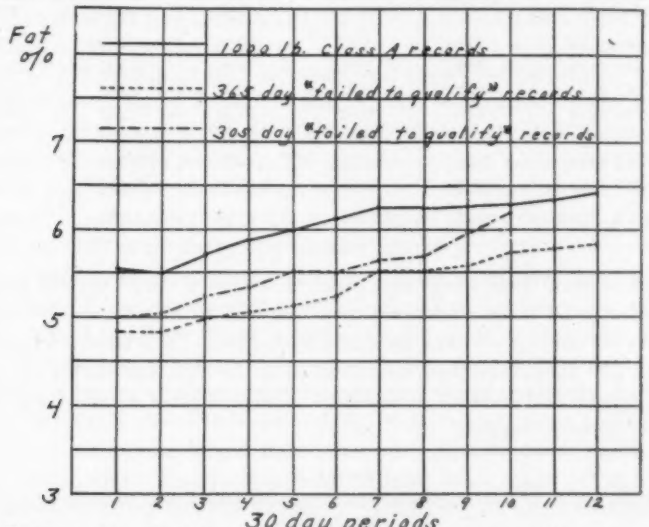

Figure 4: Fat percentage curves for 1000 lbs. class A, records, for 365 day and for 305 day low records

The foregoing data and most of the work published on persistency of production have been done with Register of Merit or Advanced Registry records. All records used were either 305 or 365 days in length for in the past the records of cows that went dry earlier and which did not meet the production requirements were not published. It seems obvious that a cow must possess a considerable degree of persistency to continue to milk for ten or twelve consecutive months following normal parturition. In the Herd Improvement Registry of the American Jersey Cattle Club, the individual records are all published on the basis of lactation periods. A lactation period includes the production beginning with the fourth day after calving until the cow is dry. The dry date is considered as the day on which a cow is last milked daily. These complete Herd Test lactation records to December 31, 1935 have now all been averaged and the averages are given in Table 1.

In examining this Table, it will be noted that of 6167 complete lactation records completed by cows of all ages, there were 576 records or 9.34 per cent which were 240 days or less in length, while 1225 records or nearly twenty per cent were 270 days or less in length. All the records of 240 days or less in length which were either first calf records or preceded by a dry

TABLE 1

Average yields of herd test lactations for all ages

LENGTH OF LACTATIONS	NUMBER	PER CENT OF TOTAL	AV. MILK YIELD	AV. PER CENT	AV. FAT YIELD
180 days or less	219	3.55	2166	5.070	109.85
181 to 210 days	120	1.95	3682	5.307	195.41
211 to 240 days	237	3.84	4357	5.165	225.06
241 to 270 days	649	10.52	5434	5.247	285.10
271 to 305 days	1471	23.85	6310	5.300	334.41
306 to 335 days	1368	22.18	7329	5.316	389.58
336 to 365 days	2063	33.45	8116	5.411	439.15
Totals	6167	100.00	6778	5.338	361.79

period of at least three weeks and which in all cases were followed by a dry period of at least three weeks and then followed by another complete lactation were sorted out. There were 144 such cases. The short lactations of less than 240 days were then compared with the next succeeding lactations both in length and in total production. Table 2 gives a tabulation of the results of this comparison.

TABLE 2

Length and yields of short lactations compared with lengths and yields of succeeding lactations

LENGTH GROUPS	SHORT LACTATIONS	NEXT SUCCEEDING LACTATIONS	PRODUCTION GROUPS	SHORT LACTATIONS	NEXT SUCCEEDING LACTATIONS
0 to 30 days	1	0	0 to 50 lbs.	5	2
31 to 60 days	1	0	51 to 100 lbs.	10	8
61 to 90 days	3	1	101 to 150 lbs.	25	14
91 to 120 days	6	6	151 to 200 lbs.	37	15
121 to 150 days	11	12	201 to 250 lbs.	31	28
151 to 180 days	14	10	251 to 300 lbs.	25	32
181 to 210 days	30	17	301 to 350 lbs.	6	15
211 to 240 days	78	17	351 to 400 lbs.	1	15
241 to 270 days	0	24	401 to 450 lbs.	1	7
271 to 305 days	0	27	451 to 500 lbs.	0	5
306 to 335 days	0	16	Over 500 lbs.	0	3
336 to 365 days	0	14			
Totals	144	144	Totals	144	144

The average length of these 144 short lactations was 198 days and the average butterfat production was 196 pounds. The average length of the next succeeding lactations of these 144 cows was 244 days and the average production was 264 pounds of butterfat. Of these 144 short lactations there were thirty which followed first calvings. These records averaged 186 days

in length and the average production for the thirty lactations was 157 pounds of butterfat. The second lactations completed by these thirty heifers averaged 243 days in length and 258 pounds of butterfat. Nineteen of the thirty heifers also had a third complete lactation and these nineteen third complete lactations averaged 255 days in length with an average production of 254 pounds of fat. In examining the second lactations completed by this group of thirty heifers, it was noticed that in only seven instances did the lactations exceed 300 days in length while there were sixteen second lactations which were less than 240 days in length. Gaines and Davidson (2) state that younger cows are more persistent milkers than older cows and Turner (3) concludes that there is a decline in persistency during the lactation period as the dairy cow reaches maturity.

Of course, nothing is known as to how these cows were handled or fed but Turner (4) has shown that overfeeding will not increase the maximum persistency of secretion which a cow inherits. It is obvious that environment, nutrition, pregnancy and season of the year of freshening are all important factors in affecting persistency and yet the evidence is that persistency is an inherited character and that some cows have an ability to hold up in production much longer than other cows handled under similar conditions. These Herd Test records were in most cases made on twice a day milking while all of the one-thousand pound records and the majority of the low Register of Merit records studied were made with three milkings per day. Frequency of milking may also be a factor which may influence persistency but the results on the Register of Merit records would indicate that such influence was not large.

SUMMARY

The significance of these results to practical breeding may be summarized as follows:

1. Total production for a lactation period seems to give some indication regarding persistency for the high producing cows were in the great majority of cases much more persistent than were the extremely low producers.

2. Maximum yield of milk or butterfat after calving does not give much information regarding persistency. Cows with the same initial rate of yield after parturition may vary greatly in persistency of production.

3. Cows with a low total production seem to reach their maximum rate of yield earlier in the lactation than do cows with a high total production.

4. Persistency seems to be an inherited character, persisting throughout a cow's lifetime. If a first calf heifer shows, under normal conditions, an inability to milk for at least eight or nine months, the chances appear against her developing into a profitable cow during later lactations.

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SOME FACTORS INFLUENCING FAT CONTENT IN ICE CREAM MIX AND THE CORRESPONDING FINISHED ICE CREAM AS DETERMINED BY THE MOJONNIER METHOD

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For a number of years there has been a belief among ice cream manufacturers that ice cream always tests lower in fat than the mix from which it was made. The difference ranges from 0.05% to as high as 0.50% with an average of about 0.20%. While seemingly small this difference has a commercial significance. Two-tenths per cent difference in butter fat based on the total weight of ice cream is equivalent to 1.75% of the total fat for a 12% ice cream. When standardizing mix to a definite percentage of butter fat, especially when it is a legal limit, the operator knows from experience that he must add extra cream and it is this "extra can of cream" that must be explained. Usually the chemist is called upon for the explanation and this had led to the development of new methods of analysis, no two of which seem to agree. There are those who claim there is no difference in the butter fat content of ice cream mix and the finished ice cream, and others who claim there is a definite loss of fat in the finished product.

L. K. Crowe (1) states that ice cream must be melted below 27° C. to prevent melting of the fat and that the fat must not be churned.

Bird and Johnson (2) compared the fat content of ten mixes and the finished ice cream made from these mixes. The average fat content of the mix was 13.44% while the frozen ice cream averaged 13.29%. In this same bulletin the investigators point out that "It is possible to induce variations as great as 1 per cent in the fat analysis of ice cream that has been melted and has been agitated to mix it."

Vasily Kniaseff in his modified Babcock method to determine fat in ice cream (3) calls attention to the fact that when the ice cream samples were not in good condition there was a discrepancy in the results and in order to use his method successfully great care must be exercised in selecting and handling the samples.

EXPERIMENTAL

In one of our plants the operators had been having trouble in getting checks between ice cream samples and the mix from which this ice cream was made. In fact they had difficulty in securing checks on samples of the same ice cream taken from different parts of the package, some of the samples varying as much as 2 per cent. It was thought that the freezing operation caused a shrinkage in the fat content. In their procedure for analysis they had always shaken the samples vigorously when melting them.

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In order to check on this, an experiment was outlined and carried out as follows: Samples of mix of different fat contents were taken from last point possible before it entered the freezer, in this case the freezer hoppers. This was done so that there would be no calculation necessary for any dilutions, such as addition of flavor or color, made at the freezer. In other words the sample was taken when all additions were made and the analysis should be exactly the same as the frozen ice cream. The ice cream for sampling was taken immediately on freezing from the freezer, placed in a regular pint package and hardened as usual in the hardening room. When hardened it was sampled in the following manner: The frozen packaged ice cream (1 pint) was cut into quarters and one of these was placed in a clean, dry half-pint milk bottle and the top covered by a disc cap and an open hood cap. The bottle was placed in a tank of water which was at a temperature of 25° C.–32° C. and allowed to stand until a clear layer formed beneath the layer of foam. Then instead of a vigorous shaking as was the general practice, the bottle was rotated carefully so that the mixture did not splash high against the sides of the bottle, but so the clear bottom layer and the top foam were thoroughly mixed. The bottle then was set in the bath and the layers allowed to separate. This procedure was repeated until two or three consecutive shakings did not result in a decrease in size of the layer of foam.

The sample for testing was then taken by dipping the end of a pipette into the clear bottom layer and drawing in the required amount. The analysis then followed the regulation Mojonnier procedure.

The results checked closely, the greatest difference being 0.09% between mix and ice cream made from the mix. It seems logical to assume that perhaps the difficulty in securing checks between ice cream and mix lay in the fact that the sample was shaken too vigorously. Table I shows the results of the analyses obtained by use of the above procedure:

TABLE I

Relation of butter fat content of ice cream mix and of ice cream when sampling was carefully done

SAMPLE	B. FAT IN ICE CREAM	B. FAT IN MIX
1 vanilla	10.01	10.04
2 vanilla	12.19	12.10
3 vanilla	16.00	15.94
4 chocolate	12.04	11.98

The above table indicates that a gentle treatment of the sample is necessary. It is generally known that the fat content of foam is high. Since much of the fat is in the foam it must be worked into solution by the repeated gentle rotations. Vigorous agitation throws fat high on the sides of

the bottle where it adheres and does not enter again the melted mixture from which the sample to be analyzed is drawn.

In order to obtain more complete information on the subject an experiment of greater scope was planned and carried out in another manufacturing plant. The standard Mojonnier apparatus and method for fat determination was used and results checked in the Research Laboratories. The ice cream mix was sampled with a small long-handled dipper and then poured into 8 ounce rubber stoppered Mojonnier sample bottles, care being taken not to wet the neck. The frozen ice cream was sampled from the cans in the hardening room by means of a 1 inch wood bit after first scraping off about ½ inch of ice cream from the top.

The samples were then allowed to warm to room temperature or were placed in warm water (29° C.) until melted after which they were allowed to stand until approximate room temperature had been reached.

The samples were mixed by gently rotating the bottle and washing down any moisture on the side walls after which the rubber stopper was loosened just enough to release the pressure. Five gram samples were immediately taken in lots of four by means of the Mojonnier 5 cc. pipettes which were inserted to approximately one-third the depth of the liquid. When one set of samples was extracted the next set was weighed and so on until three sets had been completed.

The Effect of Vigorous Shaking of Melted Ice Cream Samples

Shaking the melted ice cream samples causes a separation of fat and solids which cling to the walls of the bottle or float on the surface of the liquid and since the test sample is taken below the surface the fat content is invariably lower as shown in Table II.

Preliminary tests on the ice cream mix were made to determine any difference in composition due to standing, and to insure complete mixing. Results in Table III show that a fat separation takes place.

Agitation of the mix causes the formation of a heavy layer of foam approximately 3 inches thick. At a later date this foam from a batch of mix of lower fat content (12.46%) was sampled and analyzed as follows:

The concentration of butterfat in the foam which on standing again liquefies, probably accounts for the higher fat content of the sample of mix from the top of the batch as shown in Table IV. Since the analysis showed complete uniformity after 30 minutes gentle mixing in the holding vat, this procedure was used throughout the rest of the tests.

Observations were made in the plant to determine the usual plant practice, type of apparatus and any other factors which might have any bearing on the analytical results. All factors which were considered of importance as to the effect on the composition of the ice cream mix or frozen cream were listed as follows:

TABLE II

Influence of vigorous agitation of samples upon accuracy of butter fat tests

SAMPLE NO.	WELL SHAKEN % FAT	GENTLY MIXED % FAT
1	13.43	13.65
2	13.31	13.72
3	13.17	13.72
4	13.27	13.69
5	13.44	13.67
6	13.37	13.67
7	13.05	13.69
8	13.33	13.74
9	13.19	13.71
10	13.28	13.73
11	13.00	13.71
12	13.11	13.71
Average	13.25	13.70

Ice cream melted at room temperature (29° C.) in a closed Mason jar then placed in tightly stoppered Mojonnier sample bottles.

TABLE III

Distribution of butter fat in ice cream mix after 24 hours holding at 20° C.

SAMPLE	% FAT				AVERAGE
Top of mix in vat	13.78	13.89	13.77	13.68	13.78
Bottom of mix in vat	12.94	12.95	12.91	13.00	12.95
					13.365
	(after stirring 30 minutes)				
Top of mix in vat	13.68	13.68	13.70	13.64	13.67
Bottom of mix in vat	13.68	13.69	13.65	13.71	13.68
					13.675

TABLE IV

The butter fat and total solids in the foam on the ice cream mix

	ANALYSIS OF FOAM		ANALYSIS OF MIX
	Research Laboratories analysis	Plant Laboratory analysis	
	per cent	*per cent*	*per cent*
Fat	13.10	13.06	12.46
Total Solids	39.71	39.64	38.49

1. *Mixing.*

The ice cream mix was sometimes drawn off from the holding vat before starting the agitator or running sufficient time.

2. *Added Flavor and Color.*

Flavor and color is added at the freezer. The amount was sufficient to cause a fat reduction of 0.14% in the batches of vanilla ice cream made in this plant.

3. *Temperature and Humidity.*

More or less condensation of moisture was noted on the exposed inner walls of the holding vats as well as on the outer surfaces, depending upon the temperature and humidity. This condensation was very noticeable in the Monel metal hopper refrigerated by brine at an approximate temperature of 5° to 10° F. and into which the ice cream is run from the freezers. This hopper is funnel-shaped, 7 feet long, 7 inches wide, and 7½ feet deep.

4. *Freezing and Whipping Time.*

During the total freezing time an indefinite volume of air passes through the freezer, thereby the moisture present in the air is condensed out by the ice cream. The amount of moisture taken up depends upon the amount of this air and its relative humidity.

5. *Rinsing.*

It is customary to rinse out the freezers and hopper when changing flavors. Considerable moisture may be picked up by the first freezing after this rinsing.

Four different batches of mix and the ice cream from these mixes were sampled and analyzed, twelve separate samples being taken from each batch of ice cream mix and the finished ice cream. On batch No. 1 the results by the standard Mojonnier method of analysis were checked in the Research

TABLE V

The butter fat percentage of the ice cream mix and the finished ice cream

	BATCH NO. 1			BATCH NO. 2		BATCH NO. 3		BATCH NO. 4	
	Mix Standard Mojonnier Method	Mix Modified Mojonnier Method	Ice Cream	Mix	Ice Cream	Mix	Ice Cream	Mix	Ice Cream
1	13.87	13.90	13.65	13.91	13.65	13.85	13.54	14.09	13.80
2	13.87	13.91	13.65	13.89	13.72	13.83	13.60	14.07	13.79
3	13.84	13.85	13.68	13.86	13.72	13.84	13.57	14.08	13.79
4	13.91	13.92	13.65	13.92	13.73	13.84	13.52	14.11	13.79
5	13.99	13.91	13.67	13.88	13.69	13.85	.....	14.09	13.80
6	13.92	13.90	13.61	13.89	13.67	13.86	13.56	14.11	13.77
7	13.89	13.90	13.62	13.89	13.67	13.88	13.54	14.10	13.80
8	13.94	13.90	13.68	13.91	13.69	13.87	13.58	14.07	13.80
9	13.90	13.91	13.60	13.88	13.74	13.87	13.53	14.09	13.78
10	13.94	13.90	13.64	13.91	13.71	13.88	13.57	14.09	13.80
11	13.91	13.91	13.60	13.89	13.71	13.83	13.59	14.11	13.79
12	13.90	13.86	13.64	13.91	.....	13.82	13.55	14.06	13.81
Average	13.90	13.90	13.64	13.89	13.70	13.86	13.56	14.09	13.79
Corrected*	13.76	13.76	.....	13.75		13.72		13.95	

* 18 oz. vanilla and color added to each freezer equivalent to a fat reduction of 0.14%.

Laboratories by a slightly modified Mojonnier method in which the only difference was in drying the butter fat in an electric oven for 30 minutes.

The butter fat content of the ice cream mix is corrected for added flavor for comparison with the finished ice cream. The analysis as shown in Table V and the summary of these analyses in Table VI shows the difference in fat content between the ice cream mix and the ice cream due to the absorption of moisture during manufacture.

TABLE VI

Summary of Table V showing relation of fat difference to temperature and humidity

ICE CREAM	FAT IN MIX	FAT IN ICE CREAM	DIFFERENCE	TEMPERATURE	HUMIDITY	VISIBLE CONDENSATION IN HOLDING VAT AND HOPPER
	Per cent	*Per cent*	*Per cent*	*° F.*	*Per cent*	
1	13.76	13.64	0.12	64	38	slight
2	13.75	13.70	0.05	45	36	none
3	13.72	13.56	0.16	84	42	wet
4	13.95	13.79	0.16	81	65	wet

For 50 quarts ice cream mix per freezer (115.6 lbs.).
0.12% fat reduction is equivalent to addition of 1.00 lbs. added water.
0.05% fat reduction is equivalent to addition of 0.42 lbs. added water.
0.16% fat reduction is equivalent to addition of 1.37 lbs. added water.

SUMMARY

The largest contributing factor to variation in the fat content of ice cream mix and the finished ice cream is improper handling of the ice cream samples whereby a fat and solid separation takes place during melting making it impossible to get a representative sample for analysis.

Violent or continued agitation of the ice cream mix results in a concentration of fat and solids in the top layer of the mix and a reduction in the lower layer. The accumulated foam layer should be stirred into the ice cream mix and the agitation stopped just before drawing the mix to the freezers.

Condensation of moisture in the standardized ice cream mix and in the ice cream during freezing causes a fat reduction especially when the relative humidity is high, and when the frozen ice cream is delivered from the freezers to metal hoppers.

The adding of color and flavor at the freezers causes a definite fat reduction which may be calculated.

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STREPTOCOCCUS DURANS N. SP.

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In a previous paper (1) we described, under the cumbersome name of *Streptococcus hemothermophilus,* an actively hemolytic streptococcus obtained from milk powder. This organism was shown to be non-pathogenic for mice, rabbits and guinea pigs, and to have physiologic characteristics which differentiated it clearly from the pathogenic hemolytic streptococci. Specifically, it was shown to be markedly different from such pathogens as *S. pyogenes, S. equi,* the "animal pyogenes," and *S. mastitidis,* by its lower minimum temperature of growth, a higher maximum temperature of growth, a higher thermal resistance, and the ability to produce a lower final pH in glucose broth.

One object of this paper is to withdraw the previously applied name and suggest *Streptococcus durans* n. sp. as a more appropriate and convenient appellation. This name seems both suitable and descriptive in view of the organism's rather extreme tolerance to heat and desiccation. The former name is objectionable in that it might appear to imply a relationship to *S. thermophilus,* whereas further study of it shows that *S. durans* is in fact closely related to, and probably a member of, the "enterococcus group" of streptococci.

The more important reason for this paper is that the organism has now been studied with additional tests which are of value in showing more clearly its relationships to other streptococci, as well as expanding the description of the species.

In our former work it was shown that while this organism could be clearly differentiated from any adequately described species of streptococcus, it appeared to be most closely related to the *Streptococcus fecalis* group. Sherman and Stark (2) have shown that *S. fecalis* is able to grow in the presence of 6.5 per cent of sodium chloride, and also in media having an initial pH value of 9.6. Unpublished work in this laboratory has indicated that the ability to grow under either of these conditions is limited among the streptococci to the members of the enterococcus group—*S. fecalis, S. zymogenes,* and *S. liquefaciens. S. durans* grows in these concentrations of salt and alkali, thus showing its close relationship to the enterococci.

Sherman and Albus (3) used, among other tests, dilute medicinal methylene blue (1:20,000) in milk as a means of differentiating *Streptococcus lactis,* which was not inhibited, from *S. mastitidis,* which was inhibited. Avery (4) showed that this test also has an especial value in differentiating

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SOME FACTORS INFLUENCING FAT CONTENT IN ICE CREAM MIX AND THE CORRESPONDING FINISHED ICE CREAM AS DETERMINED BY THE MOJONNIER METHOD

J. J. JOHNSON AND J. I. ORMOND
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For a number of years there has been a belief among ice cream manufacturers that ice cream always tests lower in fat than the mix from which it was made. The difference ranges from 0.05% to as high as 0.50% with an average of about 0.20%. While seemingly small this difference has a commercial significance. Two-tenths per cent difference in butter fat based on the total weight of ice cream is equivalent to 1.75% of the total fat for a 12% ice cream. When standardizing mix to a definite percentage of butter fat, especially when it is a legal limit, the operator knows from experience that he must add extra cream and it is this "extra can of cream" that must be explained. Usually the chemist is called upon for the explanation and this had led to the development of new methods of analysis, no two of which seem to agree. There are those who claim there is no difference in the butter fat content of ice cream mix and the finished ice cream, and others who claim there is a definite loss of fat in the finished product.

L. K. Crowe (1) states that ice cream must be melted below 27% C. to prevent melting of the fat and that the fat must not be churned.

Bird and Johnson (2) compared the fat content of ten mixes and the finished ice cream made from these mixes. The average fat content of the mix was 13.44% while the frozen ice cream averaged 13.29%. In this same bulletin the investigators point out that "It is possible to induce variations as great as 1 per cent in the fat analysis of ice cream that has been melted and has been agitated to mix it."

Vasily Kniaseff in his modified Babcock method to determine fat in ice cream (3) calls attention to the fact that when the ice cream samples were not in good condition there was a discrepancy in the results and in order to use his method successfully great care must be exercised in selecting and handling the samples.

EXPERIMENTAL

In one of our plants the operators had been having trouble in getting checks between ice cream samples and the mix from which this ice cream was made. In fact they had difficulty in securing checks on samples of the same ice cream taken from different parts of the package, some of the samples varying as much as 2 per cent. It was thought that the freezing operation caused a shrinkage in the fat content. In their procedure for analysis they had always shaken the samples vigorously when melting them.

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In order to check on this, an experiment was outlined and carried out as follows: Samples of mix of different fat contents were taken from last point possible before it entered the freezer, in this case the freezer hoppers. This was done so that there would be no calculation necessary for any dilutions, such as addition of flavor or color, made at the freezer. In other words the sample was taken when all additions were made and the analysis should be exactly the same as the frozen ice cream. The ice cream for sampling was taken immediately on freezing from the freezer, placed in a regular pint package and hardened as usual in the hardening room. When hardened it was sampled in the following manner: The frozen packaged ice cream (1 pint) was cut into quarters and one of these was placed in a clean, dry half-pint milk bottle and the top covered by a disc cap and an open hood cap. The bottle was placed in a tank of water which was at a temperature of 25° C.–32° C. and allowed to stand until a clear layer formed beneath the layer of foam. Then instead of a vigorous shaking as was the general practice, the bottle was rotated carefully so that the mixture did not splash high against the sides of the bottle, but so the clear bottom layer and the top foam were thoroughly mixed. The bottle then was set in the bath and the layers allowed to separate. This procedure was repeated until two or three consecutive shakings did not result in a decrease in size of the layer of foam.

The sample for testing was then taken by dipping the end of a pipette into the clear bottom layer and drawing in the required amount. The analysis then followed the regulation Mojonnier procedure.

The results checked closely, the greatest difference being 0.09% between mix and ice cream made from the mix. It seems logical to assume that perhaps the difficulty in securing checks between ice cream and mix lay in the fact that the sample was shaken too vigorously. Table I shows the results of the analyses obtained by use of the above procedure:

TABLE I

Relation of butter fat content of ice cream mix and of ice cream when sampling was carefully done

SAMPLE	B. FAT IN ICE CREAM	B. FAT IN MIX
1 vanilla	10.01	10.04
2 vanilla	12.19	12.10
3 vanilla	16.00	15.94
4 chocolate	12.04	11.98

The above table indicates that a gentle treatment of the sample is necessary. It is generally known that the fat content of foam is high. Since much of the fat is in the foam it must be worked into solution by the repeated gentle rotations. Vigorous agitation throws fat high on the sides of

the bottle where it adheres and does not enter again the melted mixture from which the sample to be analyzed is drawn.

In order to obtain more complete information on the subject an experiment of greater scope was planned and carried out in another manufacturing plant. The standard Mojonnier apparatus and method for fat determination was used and results checked in the Research Laboratories. The ice cream mix was sampled with a small long-handled dipper and then poured into 8 ounce rubber stoppered Mojonnier sample bottles, care being taken not to wet the neck. The frozen ice cream was sampled from the cans in the hardening room by means of a 1 inch wood bit after first scraping off about $\frac{1}{2}$ inch of ice cream from the top.

The samples were then allowed to warm to room temperature or were placed in warm water (29° C.) until melted after which they were allowed to stand until approximate room temperature had been reached.

The samples were mixed by gently rotating the bottle and washing down any moisture on the side walls after which the rubber stopper was loosened just enough to release the pressure. Five gram samples were immediately taken in lots of four by means of the Mojonnier 5 cc. pipettes which were inserted to approximately one-third the depth of the liquid. When one set of samples was extracted the next set was weighed and so on until three sets had been completed.

The Effect of Vigorous Shaking of Melted Ice Cream Samples

Shaking the melted ice cream samples causes a separation of fat and solids which cling to the walls of the bottle or float on the surface of the liquid and since the test sample is taken below the surface the fat content is invariably lower as shown in Table II.

Preliminary tests on the ice cream mix were made to determine any difference in composition due to standing, and to insure complete mixing. Results in Table III show that a fat separation takes place.

Agitation of the mix causes the formation of a heavy layer of foam approximately 3 inches thick. At a later date this foam from a batch of mix of lower fat content (12.46%) was sampled and analyzed as follows:

The concentration of butterfat in the foam which on standing again liquefies, probably accounts for the higher fat content of the sample of mix from the top of the batch as shown in Table IV. Since the analysis showed complete uniformity after 30 minutes gentle mixing in the holding vat, this procedure was used throughout the rest of the tests.

Observations were made in the plant to determine the usual plant practice, type of apparatus and any other factors which might have any bearing on the analytical results. All factors which were considered of importance as to the effect on the composition of the ice cream mix or frozen cream were listed as follows:

TABLE II

Influence of vigorous agitation of samples upon accuracy of butter fat tests

SAMPLE NO.	WELL SHAKEN % FAT	GENTLY MIXED % FAT
1	13.43	13.65
2	13.31	13.72
3	13.17	13.72
4	13.27	13.69
5	13.44	13.67
6	13.37	13.67
7	13.05	13.69
8	13.33	13.74
9	13.19	13.71
10	13.28	13.73
11	13.00	13.71
12	13.11	13.71
Average	13.25	13.70

Ice cream melted at room temperature (29° C.) in a closed Mason jar then placed in tightly stoppered Mojonnier sample bottles.

TABLE III

Distribution of butter fat in ice cream mix after 24 hours holding at 20° C.

SAMPLE	% FAT				AVERAGE
Top of mix in vat	13.78	13.89	13.77	13.68	13.78
Bottom of mix in vat	12.94	12.95	12.91	13.00	12.95
					13.365
	(after stirring 30 minutes)				
Top of mix in vat	13.68	13.68	13.70	13.64	13.67
Bottom of mix in vat	13.68	13.69	13.65	13.71	13.68
					13.675

TABLE IV

The butter fat and total solids in the foam on the ice cream mix

	ANALYSIS OF FOAM		ANALYSIS OF MIX
	Research Laboratories analysis	Plant Laboratory analysis	
	per cent	*per cent*	*per cent*
Fat	13.10	13.06	12.46
Total Solids	39.71	39.64	38.49

1. *Mixing.*

The ice cream mix was sometimes drawn off from the holding vat before starting the agitator or running sufficient time.

2. *Added Flavor and Color.*

Flavor and color is added at the freezer. The amount was sufficient to cause a fat reduction of 0.14% in the batches of vanilla ice cream made in this plant.

3. *Temperature and Humidity.*

More or less condensation of moisture was noted on the exposed inner walls of the holding vats as well as on the outer surfaces, depending upon the temperature and humidity. This condensation was very noticeable in the Monel metal hopper refrigerated by brine at an approximate temperature of 5° to 10° F. and into which the ice cream is run from the freezers. This hopper is funnel-shaped, 7 feet long, 7 inches wide, and 7½ feet deep.

4. *Freezing and Whipping Time.*

During the total freezing time an indefinite volume of air passes through the freezer, thereby the moisture present in the air is condensed out by the ice cream. The amount of moisture taken up depends upon the amount of this air and its relative humidity.

5. *Rinsing.*

It is customary to rinse out the freezers and hopper when changing flavors. Considerable moisture may be picked up by the first freezing after this rinsing.

Four different batches of mix and the ice cream from these mixes were sampled and analyzed, twelve separate samples being taken from each batch of ice cream mix and the finished ice cream. On batch No. 1 the results by the standard Mojonnier method of analysis were checked in the Research

TABLE V

The butter fat percentage of the ice cream mix and the finished ice cream

	BATCH NO. 1			BATCH NO. 2		BATCH NO. 3		BATCH NO. 4	
	Mix Standard Mojonnier Method	Mix Modified Mojonnier Method	Ice Cream	Mix	Ice Cream	Mix	Ice Cream	Mix	Ice Cream
1	13.87	13.90	13.65	13.91	13.65	13.85	13.54	14.09	13.80
2	13.87	13.91	13.65	13.89	13.72	13.83	13.60	14.07	13.79
3	13.84	13.85	13.68	13.86	13.72	13.84	13.57	14.08	13.79
4	13.91	13.92	13.65	13.92	13.73	13.84	13.52	14.11	13.79
5	13.99	13.91	13.67	13.88	13.69	13.85	.....	14.09	13.80
6	13.92	13.90	13.61	13.89	13.67	13.86	13.56	14.11	13.77
7	13.89	13.90	13.62	13.89	13.67	13.88	13.54	14.10	13.80
8	13.94	13.90	13.68	13.91	13.69	13.87	13.58	14.07	13.80
9	13.90	13.91	13.60	13.88	13.74	13.87	13.53	14.09	13.78
10	13.94	13.90	13.64	13.91	13.71	13.88	13.57	14.09	13.80
11	13.91	13.91	13.60	13.89	13.71	13.83	13.59	14.11	13.79
12	13.90	13.86	13.64	13.91	.....	13.82	13.55	14.06	13.81
Average	13.90	13.90	13.64	13.89	13.70	13.86	13.56	14.09	13.79
Corrected*	13.76	13.76	.....	13.75		13.72		13.95	

* 18 oz. vanilla and color added to each freezer equivalent to a fat reduction of 0.14%.

Laboratories by a slightly modified Mojonnier method in which the only difference was in drying the butter fat in an electric oven for 30 minutes.

The butter fat content of the ice cream mix is corrected for added flavor for comparison with the finished ice cream. The analysis as shown in Table V and the summary of these analyses in Table VI shows the difference in fat content between the ice cream mix and the ice cream due to the absorption of moisture during manufacture.

TABLE VI

Summary of Table V showing relation of fat difference to temperature and humidity

ICE CREAM	FAT IN MIX	FAT IN ICE CREAM	DIFFERENCE	TEMPERATURE	HUMIDITY	VISIBLE CONDENSATION IN HOLDING VAT AND HOPPER
	Per cent	*Per cent*	*Per cent*	*° F.*	*Per cent*	
1	13.76	13.64	0.12	64	38	slight
2	13.75	13.70	0.05	45	36	none
3	13.72	13.56	0.16	84	42	wet
4	13.95	13.79	0.16	81	65	wet

For 50 quarts ice cream mix per freezer (115.6 lbs.).
0.12% fat reduction is equivalent to addition of 1.00 lbs. added water.
0.05% fat reduction is equivalent to addition of 0.42 lbs. added water.
0.16% fat reduction is equivalent to addition of 1.37 lbs. added water.

SUMMARY

The largest contributing factor to variation in the fat content of ice cream mix and the finished ice cream is improper handling of the ice cream samples whereby a fat and solid separation takes place during melting making it impossible to get a representative sample for analysis.

Violent or continued agitation of the ice cream mix results in a concentration of fat and solids in the top layer of the mix and a reduction in the lower layer. The accumulated foam layer should be stirred into the ice cream mix and the agitation stopped just before drawing the mix to the freezers.

Condensation of moisture in the standardized ice cream mix and in the ice cream during freezing causes a fat reduction especially when the relative humidity is high, and when the frozen ice cream is delivered from the freezers to metal hoppers.

The adding of color and flavor at the freezers causes a definite fat reduction which may be calculated.

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STREPTOCOCCUS DURANS N. SP.

JAMES M. SHERMAN AND HELEN UPTON WING
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In a previous paper (1) we described, under the cumbersome name of *Streptococcus hemothermophilus,* an actively hemolytic streptococcus obtained from milk powder. This organism was shown to be non-pathogenic for mice, rabbits and guinea pigs, and to have physiologic characteristics which differentiated it clearly from the pathogenic hemolytic streptococci. Specifically, it was shown to be markedly different from such pathogens as *S. pyogenes, S. equi,* the "animal pyogenes," and *S. mastitidis,* by its lower minimum temperature of growth, a higher maximum temperature of growth, a higher thermal resistance, and the ability to produce a lower final pH in glucose broth.

One object of this paper is to withdraw the previously applied name and suggest *Streptococcus durans* n. sp. as a more appropriate and convenient appellation. This name seems both suitable and descriptive in view of the organism's rather extreme tolerance to heat and desiccation. The former name is objectionable in that it might appear to imply a relationship to *S. thermophilus,* whereas further study of it shows that *S. durans* is in fact closely related to, and probably a member of, the "enterococcus group" of streptococci.

The more important reason for this paper is that the organism has now been studied with additional tests which are of value in showing more clearly its relationships to other streptococci, as well as expanding the description of the species.

In our former work it was shown that while this organism could be clearly differentiated from any adequately described species of streptococcus, it appeared to be most closely related to the *Streptococcus fecalis* group. Sherman and Stark (2) have shown that *S. fecalis* is able to grow in the presence of 6.5 per cent of sodium chloride, and also in media having an initial pH value of 9.6. Unpublished work in this laboratory has indicated that the ability to grow under either of these conditions is limited among the streptococci to the members of the enterococcus group—*S. fecalis, S. zymogenes,* and *S. liquefaciens. S. durans* grows in these concentrations of salt and alkali, thus showing its close relationship to the enterococci.

Sherman and Albus (3) used, among other tests, dilute medicinal methylene blue (1:20,000) in milk as a means of differentiating *Streptococcus lactis,* which was not inhibited, from *S. mastitidis,* which was inhibited. Avery (4) showed that this test also has an especial value in differentiating

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certain non-pathogenic hemolytic streptococci from the pathogenic types. Recent work (5, 6) has further shown that if the concentration of methylene blue is increased to 1 part in 1,000 parts of skimmed milk, all of the better known streptococci are inhibited except *S. fecalis* and its relatives in the "enterococcus group," and *S. lactis* and its relatives in the "lactic group." *S. durans* is able to grow in the presence of a 1 to 1,000 dilution of methylene blue, which also indicates that it should probably be classed as an "enterococcus."

Other tests which were not used in the previous work are for the ability to produce ammonia from peptone and to attack esculin. *S. durans* produces ammonia from peptone and attacks esculin, again showing its general relationship to the members of the enterococcus group.

In the following description we have condensed all of the available information on the organism, including those characteristics previously reported.

THE CHARACTERISTICS OF STREPTOCOCCUS DURANS

General Characteristics

The cells occur in pairs, short chains, and more rarely in long chains. Blood is hemolyzed; gelatin is not liquefied; and there is no digestion of casein in milk cultures. Litmus milk is acidulated and curdled, there being no reduction of the litmus before curdling, and slow and incomplete reduction after curdling. It is not pathogenic for laboratory animals.

Significant Differential Characteristics

Growth takes place at 10° C. and at 45° C., the maximum temperature for growth being about 50° C. It survives heating at 62.8° C. (145° F.) for 30 minutes in skimmed milk, and usually survives the same exposure at 65.6° C. (150° F.).

Sodium hippurate is hydrolyzed; ammonia is produced from peptone; final pH values of 4.4 to 4.0 are attained in glucose broth; esculin is attacked.

Growth takes place in media with an initial pH of 9.6; also in the presence of 6.5 per cent of sodium chloride; and in a 1 to 1,000 concentration of medicinal methylene blue in skimmed milk.

Fermentation Characteristics

Glucose, maltose, and lactose are fermented. Raffinose, inulin, and glycerol are not fermented. Salicin is usually fermented (37 of 40 cultures), while mannitol is usually not fermented (5 of 40 cultures). Sucrose is rarely attacked, thus sugar being fermented by only one of the 40 cultures.

NOTE

A new and more appropriate name is suggested for a species which we had previously described under another name. The change is suggested on

the basis of a more extended study of the organism, and the desirability of the change is made clear in the foregoing discussion. We change this name with no apologies. It is of course true that the codes of botanical and zoological nomenclature place severe restrictions on such an action; but bacteriologists have not formally foresworn their liberties, though conforming in general to the rules governing other biologists. The complications which arise under a too strict slavery to such conventions is well illustrated in the confusion surrounding the name *Paramecium multimicronucleatum* (7).

SUMMARY

Streptococcus durans N. Sp. is suggested as an appropriate name for the hemolytic streptococcus previously called *S. hemothermophilus*. The organism was studied by the application of more extensive tests, and a full description is given. Its close relationship to the enterococcus group of streptococci is established.

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(7) FRISCH, J. A. Science, 84: 290. 1936.

American Dairy Science Association Announcements

THIRTY–SECOND ANNUAL MEETING, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA, JUNE 22–25, 1937

GENERAL INFORMATION

The meeting will open Tuesday, June 22, and Extension Section and Production Section meetings will be held on that day. A conference of the Manufacturing Section will be held on Tuesday and the Extension Exhibits are expected to be ready on that day. A special feature on Tuesday afternoon will be a session devoted to reproductive difficulties in cattle.

Registration will begin June 21 and rooms will be available in hotels, fraternity houses, and tourist camps at rates ranging from $1.00 to $2.50 per person. Full details of housing will appear later. It is hoped that the members will bring their wives and families and a program of entertainment will be provided for them.

CALL FOR PAPERS AND ABSTRACTS

The scientific program of the association will be conducted in special sessions, and the subject matter will cover fields of production, manufacturing, extension and instruction.

Members are invited to send the titles of their papers to the program committee chairman. Non-members are permitted to read papers only upon special invitation or if a member is co-author. Papers must represent original research that has not previously been published. Titles of papers must be either accompanied by or followed by the abstract. Titles of papers must be in the hands of the committee by April 20 and all abstracts by May 1. In submitting papers the author should indicate the group before which he prefers to have his paper presented, and he will be subject to the time limit of that session. In the sectional meetings the papers are to be limited to *12 minutes* with a *3-minute* period for discussion following each paper.

Please address communications about the program to Professor H. P. Davis, Dairy Husbandry Department, University of Nebraska, Lincoln, Nebraska.

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ABSTRACTS OF LITERATURE ON MILK AND MILK PRODUCTS

BUTTER

62. Quality Butter from the Buyer's Viewpoint. R. L. FEDDERSON, Atlantic and Pacific Tea Co., Chicago, Ill. Nat. Butter and Cheese J. *26*, 9, p. 34, May 10, 1935.

Quality of butter is determined by flavor and aroma, texture or body, salt, and packaging, and of these, flavor is most important. Merchandisers must be familiar with consumers' preference in order to satisfy in each locality the demand for uniformity of color, salt, and general flavor.

The recent government quality campaign has decreased the main defects in flavor and aroma, and should cause greater consumer appreciation and demand. W.V.P.

63. An Analysis of the Oregon Plan of Grading Butter. W. F. JENSEN, Sec., American Assoc. Creamery Butter Mfgrs. Nat. Butter and Cheese J. *26*, 6, p. 8, March 25, 1935.

Butter is graded by the buttermaker on an alphabetical basis. A is 92 score or over, B is 90 and C is 89 or less. One point tolerance is allowed in the score by the state authorities. The Oregon system is not practical in interstate trade because of variations in individual standards, and the perishable nature of butter. Deterioration in quality after grading would make it impossible to guarantee scores and might therefore cause prosecutions of the seller for misbranding. W.V.P.

64. What Happens to Butter Stored at 32° F.? SIDNEY SHEPARD AND H. C. OLSON, Experiment Station, Ames, Iowa. Nat. Butter and Cheese J. *26*, 18, p. 18, Sept. 25, 1935.

Keeping qualities of salted and unsalted butter held at 32° F. and at 70° F. were compared for 14 days. Bacterial changes in both kinds of butter were more rapid at 70° F. than 32° F. but the keeping qualities of salted butter were slightly better than those of the unsalted butter. A total of 233 comparisons indicated that Nile-blue sulphate medium was not as satisfactory for determining total and proteolytic bacterial counts in butter as lactose beef-infusion agar. A list of 18 references is given. W.V.P.

Other abstracts of interest are numbers 65, 80, 81, 82, and 84.

CHEESE

65. Swiss Believe in Dairy Products—and Advertise Them. CHESTER P. HOLOWAY, Nat. Butter and Cheese J. *27*, 3, p. 16, Feb. 10, 1936.

The Swiss Milk Council, Bern, Switzerland, spent $60,000 in 1935 to increase consumption of cheese and other dairy products. Posters, slogans, and direct appeals to grocers, bakers, milk producers and consumers were used. W.V.P.

66. Good Roquefort Type Cheese Being Made by Minnesota University. Anonymous. Nat. Butter and Cheese J. *26*, 9, p. 8, Jan. 10, 1935.

A discussion is presented of the development of Roquefort type cheese curing in sandstone caves at St. Paul, Minn. Experiments to improve the cheese will be continued. W.V.P.

67. Cheese Industry Being Developed in Southern States. H. L. WILSON, Bureau of Dairy Industry, Washington, D. C. Nat. Butter and Cheese J. *26*, 2, p. 30, Jan. 25, 1935.

A brief history of the start and growth of cheesemaking in the South. W.V.P.

68. Various Methods of Manufacturing Cream Cheese. W. V. PRICE, Dept. of Dairy Industry, Univ. of Wis., Madison. Nat. Butter and Cheese J. *26*, 9, p. 18, May 10, 1935.

Three methods of making cream cheese are described. Each method requires clean, sweet, pasteurized milk or cream, clean-flavored, mild-acid, active starter, sanitary equipment and a ready market. Comparison of the three methods states that the Neufchatel method gives a high yield, is inexpensive, and adapted for use in small plant. The cheese is recommended only for local sale since it has a tendency to be crumbly and high in acid. The Geneva method requires a homogenizer and is accomplished without draining. The cheese is very smooth and inclined to be sticky. The cooked-curd method requires a homogenizer, and is widely used in large scale production because of the flavor, body, uniformity, and high yield of cheese per pound of fat. W.V.P.

69. American and Canadian Tests Show Effectiveness of Vat-Width Curd Knives. E. C. DAMROW, Pres. of Damrow Brothers Co., Fond du Lac, Wis. Nat. Butter and Cheese J. *26*, 12, p. 36, June 25, 1935.

The use of wide curd knives saves more than two pounds of cheese per thousand pounds of milk by reducing losses of curd at cutting. W.V.P.

Other abstracts of interest are numbers 80, 81, 82, and 84.

CONCENTRATED AND DRY MILK

70. Government Sets Example in Packaging of Dry Skimmilk. Anonymous. Nat. Butter and Cheese J. *26*, 13, p. 22, June 10, 1935.

Dry skimmilk, packaged in one pound sacks of Kraft paper lined with glassine makes an air-proof and water-proof package suitable for sale in stores wherever dry skimmilk is sold. W.V.P.

Other abstracts of interest are numbers 65, 80, 81, 82, and 84.

ICE CREAM

71. Operating Controlled Retail Outlets. FRANK LEGGITT, Iglo Ice Cream Co., Hammond, Ind. Ice Cream Trade J. *32*, 2, p. 25, Feb., 1936.

There are two methods of merchandising ice cream: (1) wholesale manufacturers who serve drug stores, restaurants, confectioners, and other retail outlets, and (2) retail or selling direct to the consumer.

The author states that in this rather fast growth of retail merchandising, it has afforded many advantageous services to the consumer. They are: (1) consumer is served in an attractive, comfortable store, (2) the consumer gets his money's worth, (3) the consumer may have his choice of a large variety of flavors, (4) the fact that all effort and thought is definitely placed on ice cream results in the special care and attention that is conducive to better consumer service.

The operation of retail ice cream stores presents the following complex problems: A product highly perishable, a demand fluctuating not only with seasons but also with daily temperatures, a most unstable employment requirement, a large number of small sales made by a large number of employees, cost problems, sanitation problems, the supply of raw products, advertising and accountancy details.

In merchandising ice cream, we have to develop an acceptance and demand for our product and to encourage the public to eat more ice cream. Solutions to this problem are: (1) Have a product worthy of public favor, (2) a good product in a good store will make good sales, (3) advertising, and (4) store personnel. W.H.M.

72. Eight-Month Sales Index Shows Increase of 6.77 Per Cent. O'NEAL M. JOHNSON, Statistical and Accounting Bureau, International Assn. of Ice Cream Mfgrs. Ice Cream Trade J. *32*, 2, p. 21, Feb., 1936.

The ice cream sales index showing an increase of 6.77 per cent for first eight months of 1935 is based on reports received by the Statistical and Accounting Bureau of the International Association of Ice Cream Manu-

facturers from 709 ice cream manufacturing plants with sales in 1934 of 77,686,737 gallons.

A table is given showing increases and decreases by states for the eight-month periods, January 1 to August 31, 1935, 1934, 1933, 1932, 1931, and 1930. The increase or decrease is expressed in percentage basis compared to same months in the previous year.

May and June normally produce slightly more than one-fourth the sales for the entire year. W.H.M.

73. Using Corn Sugar as an Ingredient in the Manufacture of Ice Cream. P. H. Tracy, Univ. of Ill., Urbana, Ill. Ice Cream Trade J. *32*, 2, p. 30, February, 1936.

Eastern trade demands have raised the sugar content of ice cream mix from 12 per cent up to as high as 18 per cent. A discussion of the use of cerelose as a partial substitute for the use of other sugars has been given in this article. It has been assumed that one pound of cane sugar is equivalent to 1.43 pounds of cerelose. Cerelose was used as 25 per cent of the total sugar content in mixes containing 12, 14, and 16 per cent fat.

Though the study was not complete sufficient data were collected to draw certain conclusions. The use of cerelose decreases pH slightly, lowers the color of the mix slightly, and the viscosity of the mix is lessened though there was no appreciable difference in whipping quality. The data show that cerelose has no tendency to prevent or delay the development of tallowy flavors. A higher proportion of unfrozen syrups results at any given temperature giving a smoother texture and softer body, but melting faster when exposed to room temperature. The softer body causes dipping difficulties and low yield unless dipping temperature is lowered one degree for every one per cent of cerelose used. Consumer tests show that there was little difference in flavor. Cane sugar ice cream had body preference while ice creams containing cerelose were judged sweeter. W.H.M.

74. Pasteurization of the Mix. W. H. Martin, Kansas State College, Manhattan, Kansas. Ice Cream Trade J. *32*, 5, p. 19–20, May, 1936.

Advantages gained from pasteurization are: improves the keeping quality of the mix, destroys the harmful bacteria which may be present, dissolves the mix ingredients and makes it possible to meet certain bacteria standards. Also prepares the mix for homogenization and may effect the overrun, flavor, and texture of the ice cream.

Vats should be equipped with flush-type valves, foam heaters, recording and indicating thermometers and an agitating device which will insure thorough mixing of the ingredients.

The pasteurization process really starts with the addition of the ingredients to the vats. A recommended procedure is to place liquid ingredients in the vats first and then add sugar and similar materials. About one per cent of water or skimmilk is sometimes added to the mix to make up for loss by evaporation.

Bicarbonate of soda is added to neutralize the acidity, on the basis that 0.933 pound of soda will neutralize one pound of lactic acid. The soda is dissolved in ten times its weight in water and added to the mix before it reaches 100°.

All ingredients of the mix, except the flavor, should be heated to the desired temperature, usually 150° F. for 30 minutes, and care must be taken to eliminate contamination after pasteurization. W.H.M.

75. Predicting Dealer Gallonage with a Sales Expectancy Table. Editorial. The Ice Cream Trade J. *32*, 5, p. 44, May, 1936.

An ice cream sales expectancy table based on production figures reported by the United States Department of Agriculture for 1920 to 1934 has been developed. The table can be used to predict the gallonage of a new dealer or it will indicate if a dealer is maintaining his average sales record of previous years, without looking up actual figures.

The method of setting up such a table is carefully explained, and an example of a completed table is given. Due allowance must be made, in using this table, for variations in weather conditions and general business in a territory. The table can be used to best advantage by the ice cream manufacturers who keep accurate records of daily purchases. W.H.M.

76. Dealer Education as a Means of Eliminating Contamination from Dipper Waters. D. W. Horn, Bryn Mawr, Pa. Ice Cream Rev. *19*, 11, p. 36, July, 1936.

That ice cream dipper waters are frequently sources of bacterial contamination was concluded after studying the laboratory records of counts over a period of six years. In this study, a standard of not more than 100,000 colonies per c.c. was set for dipper waters. The vendor's experience as a food handler had an influence on the bacterial count of the dipper waters. Samples from restaurants were satisfactory in the largest percentage of cases. Next in order were pharmacies, confectioneries and lastly stores. An educational program with dispensers of ice cream is shown to be effective in reducing contamination. J.H.E.

77. Ice Cream Standards—What Should Be Included in an Ideal Regulatory Law? Editorial, Ice Cream Rev. *19*, 10, p. 40, May, 1936.

There was wide difference of opinion as to what comprise ideal ice cream standards in answer to a questionnaire sent out to ice cream manufacturers

and dairy school faculty members by the Ice Cream Review. The replies received are summarized. J.H.E.

78. Quality Control in the Manufacture of Ice Cream. A. D. BURKE, Ala. Polytechnic Inst., Auburn, Alabama. Ice Cream Rev. *19*, 11, p. 42, June, 1936.

Important factors in controlling the quality of ice cream are (1) selection of quality ingredients, (2) proper blending of ingredients, (3) careful processing, and (4) laboratory analysis. J.H.E.

79. Counter Freezers vs. Factory-Made Ice Cream (A Debate). (a) Building Bigger Ice Cream Profits with a Counter Freezer. C. S. CLARK, Secy.-Treas., Counter Freezer Assn. **(b) Sound Merchandising Is the Answer to Profitable Ice Cream Sales.** E. J. FINNERAN, Director of Sales and Advertising, National Dairy Products Corp. Ice Cream Rev. *20*, 1, p. 40, Aug., 1936.

A debate which sums up the pros and cons of the counter freezer and its effectiveness in merchandising ice cream. J.H.E.

80. Floors for Ice Cream Plants. Anonymous. Ice Cream Rev. *19*, 8, p. 33, March, 1936.

The economical plan to follow when installing floors in an ice cream plant is to put a floor in each department that meets the specific requirements of that department. For these specific needs there are available floors of many different types. The particular advantages and application of various flooring materials are discussed. J.H.E.

Other abstracts of interest are numbers 64, 70, 81, 82, 83, and 84.

MILK

81. Health Education in the Schools and its Part in Increasing Dairy Food Consumption. CHESTER P. HOLWAY. Nat. Butter and Cheese J. *26*, 12, p. 24, June 25, 1936.

Americans will consume more dairy products if their value is discussed as a part of the educational work in the schools. The need of dairy products in the national diet has been increased during the depression. Surveys in some states indicate that 14 per cent of the families use no milk and little or no other dairy foods. Any long-time program for the betterment of the dairy industry must consider educational work in the schools. W.V.P.

82. A New Idea in Health Inspection for Employees of Food Plants. F. W. FABIAN, Mich. State College, East Lansing, Mich. The Ice Cream Trade J. *32*, 6, pp. 25–26, June, 1936.

The solution is daily inspection of employees coming in contact with food and dairy products by a nurse, foreman, or some one else every morning before they start to work.

Years of experience would indicate:

1. That every employee should be required to take a complete medical examination by a competent physician semi-annually.

2. That, supplementing the above examination, and as added protection, all employees coming in contact with food, milk, or other dairy products, should be examined.

3. Try to find persons suffering from a contagious disease, and penalize them by discharging or temporarily laying them off.

4. Only people who are inherently clean should be employed in the food or dairy industry. W.H.M.

83. Oxidized Fat Flavors in Milk and Ice Cream. H. H. SOMMER, Univ. of Wis., Madison, Wis. Ice Cream Rev. *20*, 4, p. 40, Nov., 1936.

A review of articles pertaining to the development of oxidized fat flavors in dairy products. J.H.E.

Other abstracts of interest are numbers, 65, 80, and 84.

MISCELLANEOUS

84. Water Supply and Waste Disposal for Dairy Plants. A. M. BUSWELL, University of Ill., Urbana, Ill. Ice Cream Rev. *19*, 10, p. 42, May, 1936.

Ways of treating water to avoid effect of hardness as well as means of disposing of dairy plant wastes are suggested. J.H.E.

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The qualifications for membership in the two classes are as follows: (a) Any person is eligible to active membership who is formally announced by an Agricultural College, or Experiment Station, or by the Bureau of Dairying of the United States Department of Agriculture as an instructor, extension worker, investigator, or administrative officer connected with the dairy industry, or (b) anyone filling a position of responsibility connected with the dairy industry and who has had a college or University training in technical science, or anyone filling a responsible position in the industry of a professional character requiring a technical knowledge of dairying of a high order.

Any person is eligible to associate membership who is regularly enrolled in a collegiate course in a college of Agriculture and who is specializing in dairying. Associate membership it attained by election to membership in a local chapter of *The American Dairy Science Association.*

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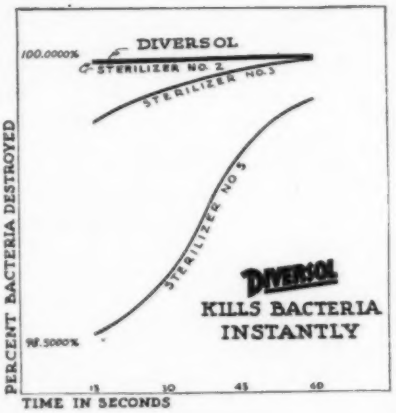

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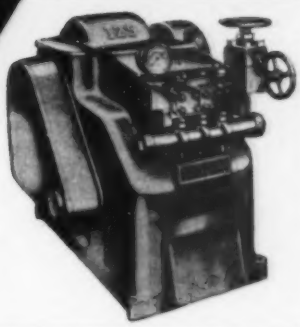

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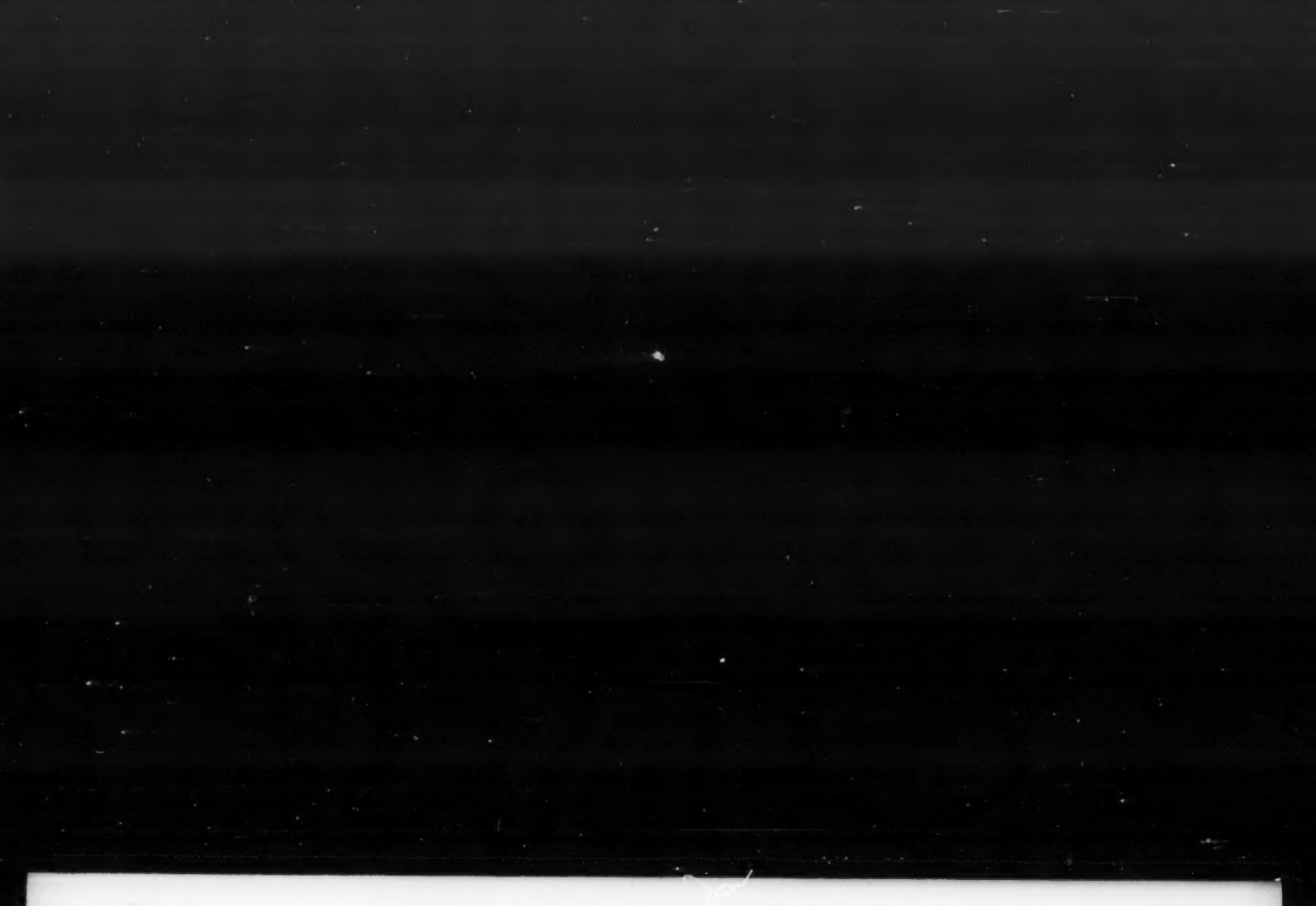

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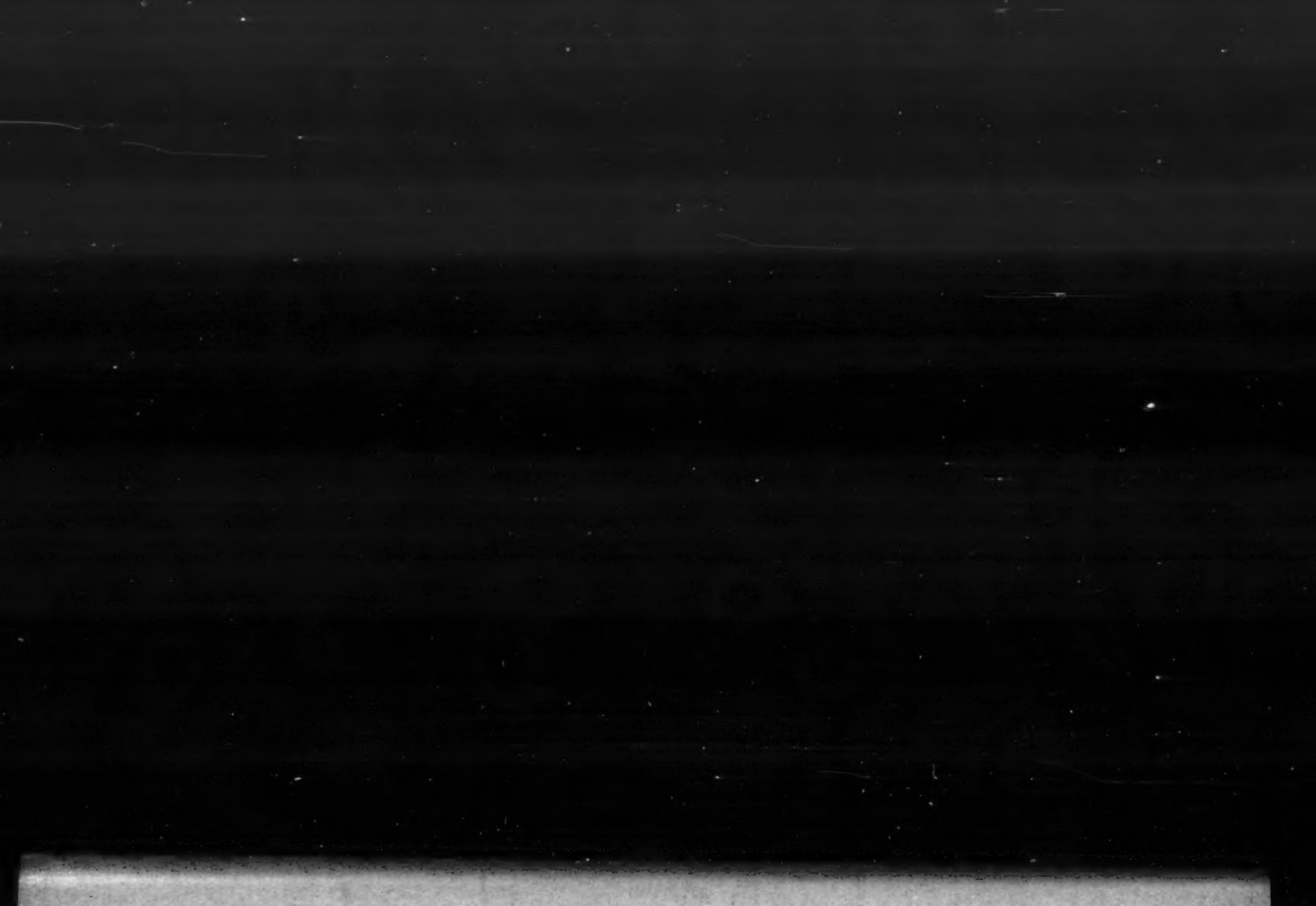

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